

SCIENCE

SEPTEMBER 1, 1950



PROBLEMS IN STATISTICAL ANALYSES
OF GEOPHYSICAL TIME SERIES

H. R. SEIWELL

A. E. V. RICHARDSON: 1883-1949

G. A. COOK

TECHNICAL PAPERS

COMMENTS AND COMMUNICATIONS

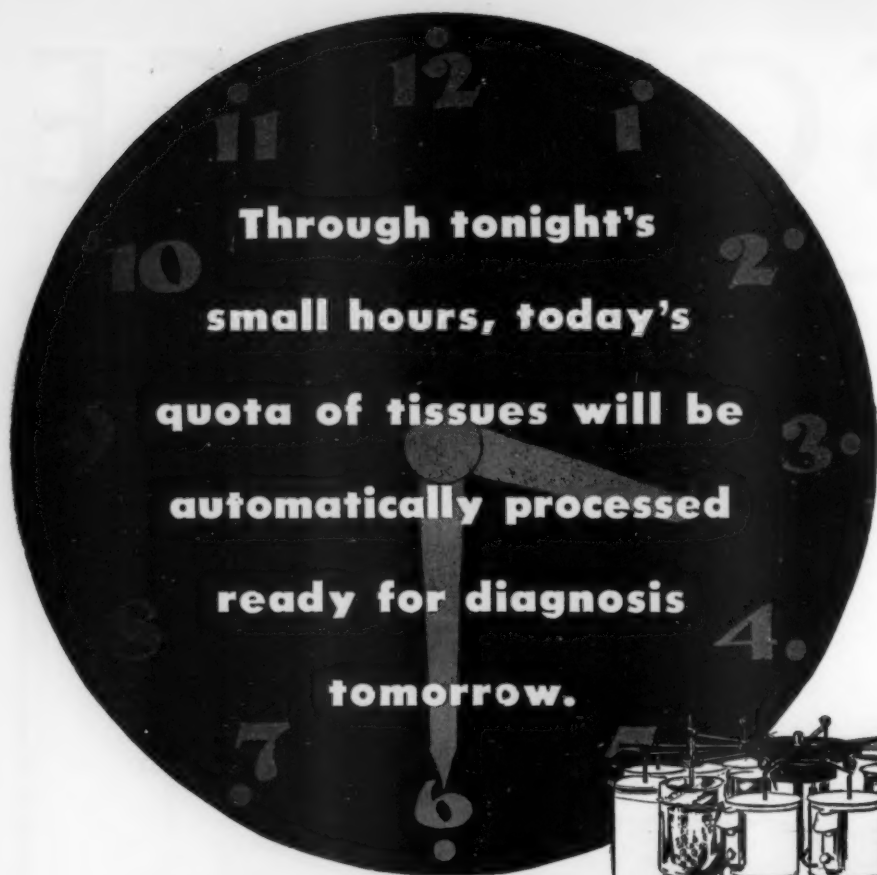
NEWS AND NOTES



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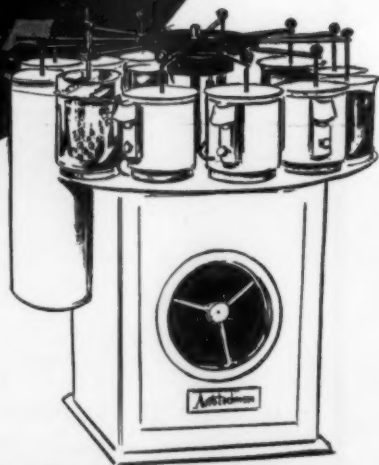
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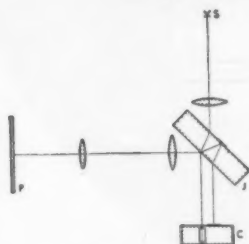


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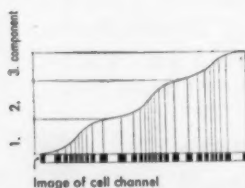


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Table of Contents

Problems in Statistical Analyses of Geophysical Time Series:

H. R. Seiwell 243

A. E. V. Richardson: 1883-1949:

G. A. Cook 247

Technical Papers

The Influence of Glutamic Acid on Test Performance: D. G. Ellison, Paul R. Fuller, and Robert Urmston 248

The Measurement of Radioactive Hydrogen in Solid Samples—Comparison with Gas Counting: Maxwell Leigh Eidenoff and Joseph E. Knoll 250

A Maternal Influence on the Incorporation of Methionine into Liver Protein: Robert J. Rutman 252

Phenylhydrazine Oxalate as "Trapping Agent" for the Simultaneous Fixation of Intermediate Products in Lactic Acid Fermentation with Living Cells: V. Bolcato 252

The Experimental Feeding of Parathion to Dairy Cows: Paul A. Dahm, F. C. Fountaine, and Joseph E. Pankaskie 254

A Rational Method for Calculating Colloid Osmotic Pressure of Serum: Russell H. Kesselman 255

Decreased "Hunger" but Increased Food Intake Resulting from Hypothalamic Lesions: Neal E. Miller, Clark J. Bailey, and James A. F. Stevenson 256

Comments and Communications

"Funginert"—A Designation for Inherently Fungus-resistant Material: Walter N. Ezekiel 259

Quantum Theory and Phytoplankton Photosynthesis: Jacob Verduin 260

Our Decelerating Planet: Paul D. Harwood 260

News and Notes 261

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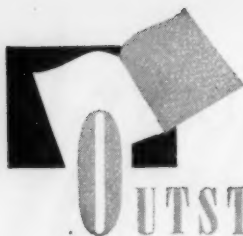


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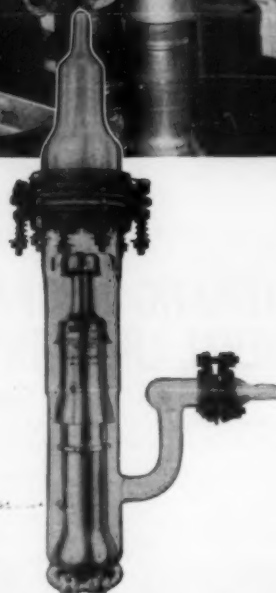
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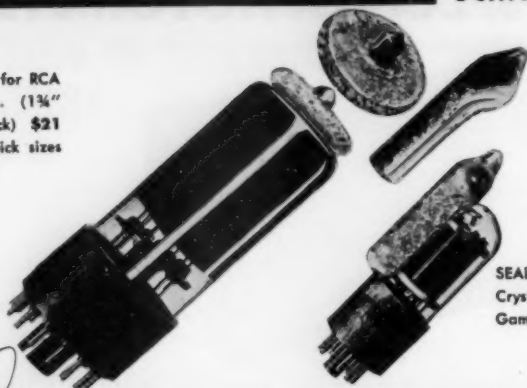
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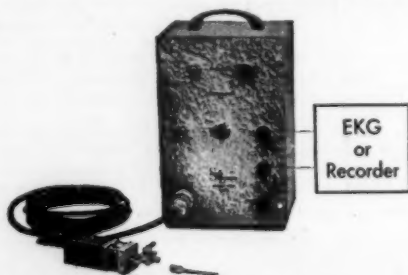
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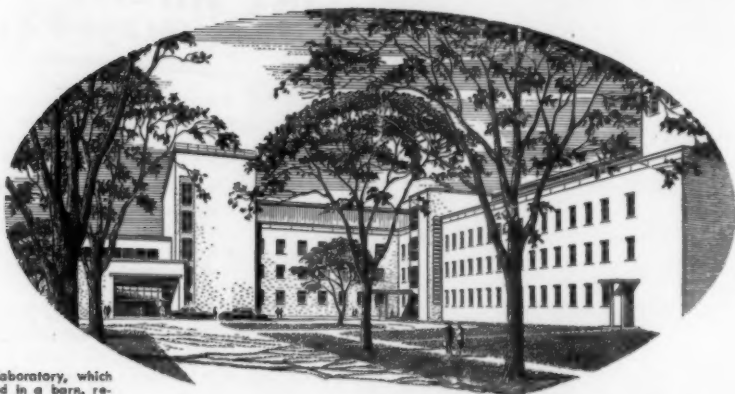
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Problems in Statistical Analyses of Geophysical Time Series¹

H. R. Seiwel

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

AS AN EXAMPLE OF GEOPHYSICAL TIME SERIES we concern ourselves with sea surface wave data, the preparation of this article having been prompted by a recent paper on ocean waves by G. E. R. Deacon (3). Deacon and his co-workers have carried out extensive investigations of sea surface wave phenomena at Pendeen, England, from which they conclude that a heterogeneous system of waves is transmitted to a distance as a group and can there be analyzed. Records of wave height against time at fixed locations are mechanically analyzed by a periodogram technique, and the sea surface wave patterns are then represented as a number of frequencies of varying amplitudes. In actual practice, the Pendeen wave records, each of approximately 20 minutes' duration, are subjected to analysis on a specially constructed ocean wave frequency analyzer. The procedure is believed to isolate the constituent elements, whose sum composes the series of the sea surface wave pattern.

The wave period (or wave frequency) analysis of the Pendeen records applies a periodogram technique to data of finite scope as it comes from nature. The physical significance of the results of this analysis is believed to be shown by the general outline of the resulting spectrum. In particular, significance is attached to the occurrence of a "prominent frequency band," which persists through a number of consecutive spectra. This is interpreted to mean that waves between the indicated period limits are physically present in the sea surface wave patterns, discrete frequencies being indicated by individual peaks.

As an example of the interpretation, we refer to published wave spectra of Pendeen sea records dated 0500 to 1900, July 1, 1945 (1). Each of the spectra shows a prominent frequency band containing 25 or more individual peaks between 7 and 14 seconds (ap-

proximately). According to the Pendeen interpretation, this indicates the presence of a band of surface waves with periods between 7 and 14 seconds that has traveled from a distant storm-generating area, each individual wave (identified by the peak in the spectrum) having a velocity proportional to its period. The physical postulate is important, and, as alternate ones exist, we shall briefly examine the extent to which one may reasonably formulate a physical hypothesis from results of a mathematical analysis of a geophysical time series.

The problem of searching for hidden periodicities in natural and economic time series is an old one for which no satisfactory general solution appears to have yet been found (2). Mathematical methods, based on theory of infinite series, generally require some modification when applied to natural phenomena of finite scope, because the system, though safe for the problem for which it was developed, may become unsafe in other uses. Investigations of time series have, in particular, been influenced by the classical work of Schuster (8), who introduced probability theory into a method for determining hidden periodicities, developed for a specific purpose. The method of Schuster or, more generally, one of its modifications (for instance, that of Whittaker and Robinson [12]) has been used in many types of times series analysis, and in such a fashion as to suggest the physical occurrence of periods and cycles in numerous economic and natural time series. In contrast, we have the opinion of statisticians that the method of periodogram analysis as a means of searching for periodicities appears rarely, if ever, to have been successful in geophysical and economic work. Although exact for infinite series, it appears to give insufficient information when applied to observational data of finite scope.

The methodology of searching for periodicities has, in particular, been discussed at length by Bartels (2), Wilson (13, 14), Yule (15), and Kendall (4, 5, 6).

¹ Contribution No. 505 from the Woods Hole Oceanographic Institution and the Office of Naval Research, Contract N6ONR-277/1.

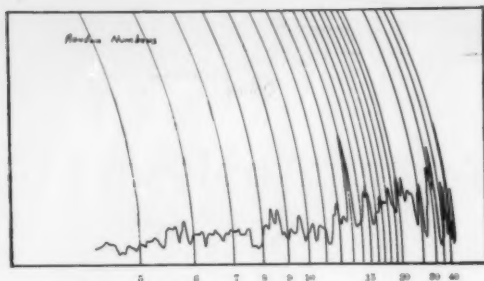


FIG. 1. Frequency spectrum of Tippet's random numbers from periodogram analysis by the ocean wave analyzer. (Period of waves in seconds.)

Wilson, in an elaborate series of experiments with the Schuster periodogram technique, cast doubt on the validity of periods or cycles in the *Ayres' Index of American Business Activity*. More recently, the experimental approach of Kendall appears to confirm the unreliability of the Schuster and related techniques of cycle analysis as a means of discovering from natural data the fundamental laws by which they were generated. Thus, Kendall's investigations reasonably demonstrate that the spectra of periodogram analyses of data having finite scope—that is, when limited (and workable) amounts of data only are available—may not only fail to indicate the true character of the oscillation, but also show unexplained spurious peaks not related to the physical character of the phenomenon dealt with. On the other hand, we find Barber and Ursell (1) proposing a theoretical justification of the Pendeen periodogram technique, but without experimental demonstration of their results.

The above points are illustrated by periodogram analyses of two experimental examples (Figs. 1, 2). The periodogram spectrum of each model was obtained by use of a wave frequency analyzer basically similar to the Pendeen model (7). Fig. 1 is the spectrum given for Tippet's (11) random numbers, which were plotted and then painted on a tape to resemble a natural wave record. Fig. 2 is the analyzer spectrum of the function $2.5 \sin \frac{2\pi}{12} t + \epsilon$, arranged in the same fashion. Either spectrum resembles that obtained from similar analysis of an ocean wave record. The random number spectrum shows well-defined teeth (periods?) at 13 and 30 seconds bounding a reasonably prominent "frequency band." The second function is revealed as a 12-second period, being part of a well-defined "period band" between 11 and 17 seconds, together with other well-defined peaks for higher periods. The examples demonstrate the danger of

deducing physical properties of ocean wave records from periodogram spectra.

The foregoing discussion may appear somewhat destructive in that, if the main conclusions are correct, they indicate that inferences based on periodogram analysis of ocean wave data may require some reconsideration. Methods of statistical inference, whereby we hope to determine the physical properties of data that are finite in scope (and not excessively long) in order to discover something of the physical causes, require information beyond that given by the periodogram. In certain situations, computation of the autocorrelation function and plotting of the correlogram appear to provide this additional information. It was to this end that Seiwel and Wadsworth (10) applied the method of autocorrelation analysis to ocean wave records (wave height variations with

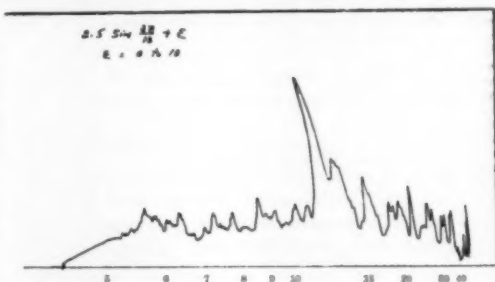


FIG. 2. Frequency spectrum of the function $2.5 \sin \frac{2\pi}{12} t + \epsilon$ from periodogram analysis by the ocean wave analyzer. (Period of waves in seconds.)

time) and, in their earliest analyses, found situations where the sea surface wave pattern was referable to one main trigonometric plus a residual with a random component. From this it was postulated that the main trigonometric was "sea swell" generated at a distance, and that the remainder of the pattern, "sea," was generated locally. This differed from current interpretations of sea surface wave patterns which, from results of periodogram analyses, were interpreted to be a combination of waves of many frequencies generated by a distant storm, and which had independently traveled from that area to the target. The idea of a single frequency, only, reaching the target at any one time from a distant storm, and on which is superimposed locally generated disturbances of the same average frequency as the fundamental, had not been considered.

Hence, differences in the two postulates concern the physical origin of sea surface roughness patterns at a target distant from the generating area. Seiwel and Wadsworth infer that the ocean acts as a filter, and that, after a certain distance from the storm-generat-

ing area, swell of a single period is all that remains of the wave pattern. This single wave has been termed the dynamic component of the sea surface roughness pattern, and its period and amplitude change with time are referred to a distant target. On the other hand, the postulate supported by Deacon and his co-workers proposes that conditions of the generating area may be sampled at a distant target and subsequently evaluated. It is the opinion of this writer that weakness in the latter postulate lies in the statistical methods on which the physical inference is based.

Although it is apparent that the real physical picture of the sea surface roughness pattern will result only from extensive series of observations between generating areas and distant targets, the extreme difficulty and expense involved will, for the present, make

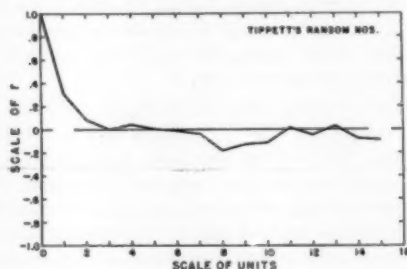


FIG. 3. Correlogram obtained from 250 of Tippett's random numbers.

it necessary to base knowledge of the physical properties of the sea surface primarily on wave observations from near-shore localities. In view of possible significance of inferences to be drawn from results of autocorrelation analysis, an experimental investigation of the autocorrelation function and the resulting correlogram, and of the power spectrum, was carried on parallel with correlogram analyses of ocean wave records from North Atlantic localities. Present indications are that, although the correlogram provides more information than the periodogram spectrum (of finite data), it is limited to determinations as to whether the basic series is random, periodic in one term only, periodic in more than one term, or completely autoregressive according to the scheme of Kendall.

In the practical computation² of the normalized autocorrelation function, r_k , from finite amounts of data (N), we use the formula

$$r_k = \frac{\sum_{i=1}^{N-k} \frac{X_i X_{i+k}}{N-k} - \left(\frac{\sum_{i=1}^{N-k} X_i}{N-k} \right) \left(\frac{\sum_{i=1}^{N-k} X_{i+k}}{N-k} \right)}{\sigma^2}$$

where σ^2 is the variance of the series. The correlo-

² Computation is now carried out on an especially designed mechanical autocorrelator.

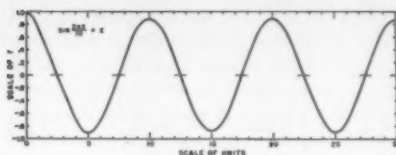


FIG. 4. Correlogram obtained from $\sin \frac{2\pi}{10} + \epsilon$.

gram is obtained by plotting r_k against k ; r_0 is set equal to 1.

For a random series, the correlogram is a strongly damped exponential (Fig. 3) of the form

$$r_k = e^{-\lambda k}$$

In the special case where the basic series contains a single sine wave, the correlogram is a cosine curve of that period, having equal distances between successive peaks and successive valleys (Fig. 4), and damping to a terminal amplitude, the value of which depends on the percentage variability of the basic trigonometric to the total data. On the other hand, when the basic series contains several cyclical terms, the correlogram will not have a constant period, distances between successive peaks and successive valleys are not constant, and damping is not consistent over more than two or three cycles. Distinction between the two types of series becomes apparent after two, and not more than four, cycles of the correlogram have been examined.³ For this situation, additional information may sometimes be obtained by a Fourier transform of the autocorrelation function into its approximate power spectrum. In the special case of the basic data being completely autoregressive, the correlogram damps to zero after a few cycles.⁴

Correlograms of the two series previously discussed (Figs. 1, 2) are illustrated by Figs. 3 and 4. Fig. 3 is the correlogram of a series of 250 equally spaced random numbers (Tippett). The damping factor λ is about 1.2. The correlogram shows some persistence and small correlation in that the numbers themselves are not strictly random. However, there is no suggestion of periodicity, a sharp contrast to the peaks or teeth brought out in the periodogram spectrum of this same series (Fig. 1).

As a second example of a correlogram application to finite data, the function $y = A \sin \frac{2\pi}{10} + \epsilon$ is considered. A had a value of 1, and ϵ was drawn from Tippett's random numbers, as before. The correlo-

³ This is based on unpublished experimental data on file at this Institution.

⁴ For discussion of properties of autoregressive series, see the various works of M. G. Kendall (4, 5, 6). Only one case of completely autoregressive wave data has been found by this author, this being a record taken off Scripps Pier, La Jolla, Calif., dated November 5, 1948.

gram computed from 250 equally spaced digits (Fig. 4) reveals the period of the original trigonometric. In the first cycle, it damps to a value $r_T=0.88$ and thereafter remains nearly constant; at the third cycle $r_T=0.86$ (within limits of computational error). If the function had been unknown and given only as a series of values, the foregoing analysis permits computation of the following properties.

Period, $T=10$ units

Variance cosine, $\frac{A^2}{2}=0.500$

Total variance, $\sigma_y^2=0.588$

Residual variance, $\sigma_r^2=0.088$

Terminal amplitude, $r_T = \frac{\text{variance cosine}}{\text{total variance}} = 0.85$

Total standard deviation, $\sigma_y=0.7668$

Total average deviation, $AD_y=.656$

$\frac{AD_y}{\sigma_y}=0.856$

When a cosine wave of 10 units was fitted to the basic data ($y=A \sin \frac{2\pi}{10} + \epsilon$), the least square amplitude was computed to be $A'=0.991$, nearly identical with the original amplitude of $A=1.00$.

Thus, if the above series had been a natural wave record, we would infer the following characteristics: The sea surface wave pattern consisted of one fundamental wave (swell) with a period of 10 seconds and an amplitude of 1 foot on which has been superimposed a series of local impulses (sea). The former, presumably generated by a meteorological situation acting at some distance from the target, is the predictable component in the data and accounts for an estimated 85 percent of the total variability of the sea surface wave pattern. It is this component that may be forecast from knowledge of wind action on

the sea surface. The remainder of the data represents a series of superimposed local impulses, generated by local winds, which die out rather rapidly when the energy source is removed.

The correlogram of the above model is typical of that sometimes obtained from ocean wave data. Eight examples of such analysis have been published (9), in two of which (53-X and 39-L) correlogram analyses were carried out over 17 and 124 cycles, respectively. In each case the amplitude of the single trigonometric was determined by a least square fit of a cosine curve of the period isolated by the correlogram. It is suggested that a quantitative distinction between swell generated at a distance and the locally produced sea is possible. When only one period is present in the basic series, it is to be expected that it changes with time and at a rate dependent on the stability of the offshore causative meteorological situation. On the other hand, the local sea is induced by local winds and other factors tending to disturb the sea surface, and it dies out fairly rapidly.

In the foregoing, some of the problems associated with geophysical time series analysis have been briefly discussed. Hypotheses for both periodogram and correlogram analysis were originally developed for problems of infinite series, and the background mathematical theories are understood. Uncertainty in their application arises when the object is to discover from experimental or observational data (of finite scope) something about the physical laws by which they were generated. Hence, prior to extensive use of either method, it appears pertinent that mathematical models of a type known to occur in nature be studied, both experimentally and theoretically, to develop ideas that will help to define the problems and to identify the basic laws underlying particular sequences of data.

References

1. BARBER, N. F., and URSELL, F. *Phil. Trans. Roy. Soc. Lond.*, 1948, **A240**, 527.
2. BARTELS, J. *Terr. Mag.*, 1935, **40**, 1.
3. DEACON, G. E. R. *Quart. J. Roy. Met. Soc.*, 1949, **75**, 227.
4. KENDALL, M. G. *J. Roy. Stat. Soc.*, 1945, **108**, 93.
5. ———, *Nat. Inst. Econ. Res., Occ. Papers IX*, Cambridge Univ., 1946.
6. ———, *The advanced theory of statistics*, Vol. II. London: Charles Griffin, 1948.
7. KLEBBA, A. A. *Ann. N. Y. Acad. Sci.*, 1949, **51**, 533.
8. SCHUSTER, A. *Terr. Mag.*, 1898, **3**, 13.
9. SEIWELL, H. R. *Proc. Nat. Acad. Sci.*, 1949, **35**, 518.
10. SEIWELL, H. R., and WADSWORTH, G. P. *Science*, 1949, **109**, 271.
11. TIPPETT, L. H. C. *Tracts for computers*, No. XV, Cambridge, 1927.
12. WHITTAKER, SIR EDMUND, and ROBINSON, G. *The calculus of observations*, 4th ed. London: 1948.
13. WILSON, E. B. *Quart. J. Econ.*, 1934, **375**.
14. ———, *Science*, 1934, **80**, 193.
15. YULE, G. U. *Phil. Trans. Roy. Soc. Lond.*, 1927, **A236**, 267.



A. E. V. Richardson: 1883-1949

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ON DECEMBER 5, 1949, at the age of 66, Dr. A. E. V. Richardson died in Melbourne. For the last forty years he had given distinguished service to the agricultural and pastoral industries of Australia. Born in Adelaide, Dr. Richardson began his work in agriculture when he was a student at Roseworthy Agricultural College. He studied science at the University of Adelaide, where he graduated M.A., B.Sc. In 1909 he was appointed assistant director of agriculture in South Australia and in 1911 was transferred to the Victorian Department of Agriculture as superintendent of agriculture. The purpose of his appointment was to put the activities of the department on a scientific basis, and Richardson threw himself into his work with tremendous energy, changing the whole basis of departmental advice from "expert" opinion to the results of carefully planned experiments. He reviewed the scope of the state research farms and consolidated their work into three main stations—the Experiment Farm at Rutherglen, where work on the top dressing of pastures led to the establishment of subterranean clover throughout Victoria; the Central Research Farm at Werribee, working on cereal breeding; and Longerenong Agricultural College, which was responsible for the introduction of improved cultivation methods of wheat farming. As a result of his work new wheat varieties were developed and many improvements made in wheat-farming practice. Wheats developed from Werribee now represent 86 percent of the acreage sown to this crop in Victoria. His publication *Wheat and Its Cultivation* became a standard text on the subject in Australia, and for this work and research on the water requirements of farm crops he received in 1924 the first D.Sc. degree awarded in agriculture by the University of Melbourne.

In 1918 Richardson visited the United States and Canada for the Victorian Government to study agricultural education and research. As a result of his report on the visit, the School of Agriculture was established on its present basis at the University of Melbourne, and Richardson was appointed dean of the faculty and director of the school. He held these posts in addition to his position with the Department of Agriculture and thus ensured a close link between the educational and research activities of the university and the requirements of the department for research and extension workers.

In 1924 Peter Waite, a prominent South Australian

pastoralist, presented his estate on the outskirts of Adelaide, together with a considerable endowment, to the University of Adelaide, which, as a result, was able to establish the Waite Agricultural Research Institute and the Waite Chair of Agriculture. Richardson accepted an invitation to be first director of the institute and occupant of the chair. In his new post, he was responsible for the development and expansion of the activities of the Waite Institute to its present leading position among the agricultural research institutes of Australia. In 1927 Richardson was appointed a member of the Executive Committee of the newly formed Council for Scientific and Industrial Research, a position he held until his retirement in 1949, and there is no doubt that his skillful judgment and wide knowledge of Australian agricultural problems contributed largely to the early success of the council in selecting problems for research which yielded such valuable results for Australian primary industries. In 1938 he left the Waite Institute to become deputy chief executive officer of the C.S.I.R. and in 1946, on the retirement of Sir David Rivett, he was appointed chief executive officer, a post which he held till his retirement in 1949. In 1927 Richardson was a delegate to the first Imperial Agricultural Research Conference in London and in 1932 an official adviser to the Australian delegation to the Ottawa Conference. He was created C.M.G. in 1932. He was the first president of the Australian Institute of Agricultural Science in 1935 and in 1947 was president of the Australian and New Zealand Association for the Advancement of Science. His presidential address, "Science in Relation to Australia's Development," is a brilliant survey of the possibilities of research in Australia.

Richardson was a big man in mind and stature, and his genial, unassuming manner won him warm friends in many walks of life. Apart from his work he had wide interests, especially in the arts and in various games, in which he possessed greater than average skill. He had an encyclopedic knowledge of agricultural matters and a prodigious memory for facts and figures, which made him a formidable opponent in argument. In addition to his ability as an experimenter and his unfailing judgment of the practical value of research, he possessed a capacity for solid work and careful attention to detail that made him a successful administrator.

He is survived by his wife and daughter.

Technical Papers

The Influence of Glutamic Acid on Test Performance¹

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Zimmerman, Burgemeister, and Putnam (3) have recently reported an experiment from which they conclude that "glutamic acid accelerates mental functioning in human subjects," and "the most striking results appear in the seriously retarded group, where statistically significant differences are obtained between test and retest intelligence quotients." Because of a number of criticisms that may be raised against the design of this experiment and some of the statistical treatments, the study has been repeated by the authors with certain necessary changes.

The basic objection to the original experiment is the lack of adequate control for the effects of knowledge on the part of the test administrators that glutamic acid was being administered. As controls Zimmerman used 37 of the 60 subjects included in the experimental group, determining changes in their I.Q.'s during a period 6 months to 8 years prior to the experiment. Inasmuch as the experimental and control treatments occurred at different times, it seems almost certain that those who administered the tests knew that glutamic acid was being given between the pre- and post-tests. At least, no attempt to control this important variable is reported. Because the scoring of parts of the Stanford-Binet is far from objective, it is quite possible for enthusiastic testers unintentionally to modify scores in favor of the experimental results.

A second criticism of the Zimmerman experiment concerns the selection of the retarded group, which was done in such a way as to produce a regression error in favor of the obtained difference. The mean score of any subgroup that is selected on the basis of test scores, and that has a mean score different from that of the larger group, can be expected to regress toward the mean of the larger group when retested. The expected change in the subgroup mean is proportional to $D(1-r)$, where r is the correlation between pre- and post-test scores, and D is the difference between the two means. In this case, r is the reliability coefficient of the Stanford-Binet. The obtained reliability is not given, but assuming an r of .90, the estimated regression is 1.3 I.Q. points, reducing

¹ The writers wish to acknowledge the very helpful cooperation of the administration and personnel of the Muscatatuck State School and of Benson Scodel, who provided medical supervision.

² This research was supported by a grant from the Graduate School of Indiana University, which provided a one-year fellowship for Robert Urmston.

the gains due to other variables present in the experiment from 6.3 to 5.0.

A third criticism concerns the computation of D/σ_D . Sufficient data are presented in Zimmerman's Tables I and II to indicate that the correlation term was omitted in computing σ_D . The correlation involved is again the reliability of the Stanford-Binet. Conservatively estimating this r as .90, we find that D/σ_D is raised from 1.65 to 5.04 in the total group, and from 3.02 to 11.05 in the retarded group, indicating that highly significant gains were actually obtained in both groups. Unfortunately, statistically significant differences have no meaning unless experimental controls are adequate.

The present experiment was designed for more adequate control by the use of two groups run simultaneously under identical conditions except for the experimental variable. Until the experiment was completed, only one person, who did not otherwise participate in the experiment, knew which group received glutamic acid, and which the placebo.

Subjects for the experiment were two groups of 30 children, inmates of Muscatatuck State School, who ranged in age from 9 to 17 years. Stanford-Binet I.Q. from 16 to 70. The two groups were matched by pairs for age and I.Q., as shown in Table 1.

TABLE 1
RESULTS OF MATCHING AND CONTROL GROUPS

Group	Binet I.Q.		Age	
	M	σ	M	σ
Experimental	49.05	13.6	12.5	2.07
Control	49.00	14.5	12.9	2.26

Four tests were administered in addition to the Stanford-Binet: The Cornell-Coxe Performance Ability Scale, a tapping rate test, a coordination test (star tracing), and a test of memory span for digits. The test-retest reliability of these measures is presented in Table 2.

TABLE 2
TEST-RETEST RELIABILITY OF SCORES

Test	9/47 to 2/48	2/48 to 6/48	9/47 to 6/48
Stanford-Binet (I.Q.)	.94	.93	.95
Cornell-Coxe	.93	.94	.95
Tapping rate	.91	.91	.86
Coordination			
Time	.67	.67	.37
Errors	.80	.74	.72
Digit span	.92	.89	.79

Tests were administered to all the subjects by psychologists from the Department of Psychology at Indiana University in September, 1947, February, 1948, and

TABLE 3
MEAN DIFFERENCES IN TEST SCORES ON SUCCESSIVE TEST ADMINISTRATIONS. NEGATIVE VALUES INDICATE
POORER PERFORMANCE ON THE SECOND TEST OF EACH PAIR

Test	Initial mean score	9/47 to 2/48			2/48 to 6/48			9/47 to 6/48		
		D	t	p	D	t	p	D	t	p
A. Experimental group										
Stanford-Binet (I.Q.)	49.05	5.00	5.59	< .01	0.18	.28	> .05	5.18	4.39	< .01
Cornell-Coxe	109.00	17.93	3.76	< .01	1.07	.18	> .05	19.00	4.61	< .01
Tapping rate*	62.50	7.25	3.90	< .01	0.00	...	> .05	7.25	4.03	< .01
Coordination										
Time	13.21	0.07	.06	> .05	1.07	1.22	> .05	1.14	1.03	> .05
Errors	24.21	2.78	1.81	> .05	-1.28	1.04	> .05	1.50	.85	> .05
Digit span	4.65	0.15	.08	> .05	0.07	0.05	> .05	.22	.12	> .05
B. Control group										
		D	t	p	D	t	p	D	t	p
Stanford-Binet (I.Q.)	49.00	4.05	3.00	< .01	-0.73	.58	> .05	3.32	2.86	< .01
Cornell-Coxe	99.33	22.00	5.74	< .01	3.54	.53	> .05	25.54	4.11	< .01
Tapping rate*	59.19	4.25	2.58	< .05	0.94	.42	> .05	5.19	2.19	< .05
Coordination										
Time	12.36	-3.14	2.76	< .05	-0.71	.60	> .05	-3.85	2.12	< .05
Errors	25.00	6.60	3.80	< .01	1.93	1.66	> .05	7.93	4.02	< .05
Digit span	4.57	0.03	.02	> .05	0.31	0.12	> .05	0.34	0.12	> .05

* Tapping rate as here given is number of taps in 15 sec, average for 10 trials.

June, 1948. Forms L and M of the Stanford-Binet were alternated in the three testing periods, the remaining tests being the same in each period. Test administrators were the same for the first two and different for the third.

Following the first administration of the test battery, the 60 subjects were divided into two matched groups identified (to school personnel) as A and B. Group B was given sodium-neutralized 1(+) glutamic acid mixed in 8 oz whole milk or tomato juice. The initial daily

vent both school personnel and psychometrists from knowing which treatment was given to either group.

Table 3 presents the mean change in test scores and the statistical significance of the changes for both groups. The Stanford-Binet I.Q., Cornell-Coxe scores, and tapping rate show significant gains for both groups, with the major part of the gain occurring during the first 5 months of experimentation. The coordination test showed a significant increase in time and decrease in errors in the

TABLE 4
COMPARISON OF MEAN CHANGES IN TEST SCORES FOR EXPERIMENTAL AND CONTROL GROUPS. NEGATIVE DIFFERENCES INDICATE THAT LESS IMPROVEMENT WAS SHOWN BY EXPERIMENTAL GROUP THAN BY CONTROL GROUP

Test	9/47 to 2/48			2/48 to 6/48			9/47 to 6/48		
	D	t	p	D	t	p	D	t	p
Stanford-Binet (I.Q.)	.95	.63	>.05	.91	.70	>.05	1.86	1.16	>.05
Cornell-Coxe	-4.07	.57	>.05	-2.47	.347	>.05	-6.54	.85	>.05
Tapping rate	3.00	1.46	>.05	-.94	.41	>.05	2.06	.71	>.05
Coordination									
Time	3.21	2.02	>.05	1.78	1.33	>.05	5.00	2.44	<.05
Errors	-3.22	1.42	>.05	-3.21	1.74	>.05	-6.43	3.72	<.01
Digit span	.12	.048	>.05	-.24	.888	>.05	-.12	.0323	>.05

dose was 4 g, increasing over a period of 42 days to the maximum of 30 g, which was maintained for the remainder of the experiment. Group A, the control group, was given a placebo, also mixed in milk or juice, consisting of 14 g corn sugar, 4 g sodium bicarbonate, and 1 g table salt, which produced a taste change in the mixture somewhat similar to the glutamic acid. The dosage was given to both groups after breakfast and at 2:30 P.M. The glutamic acid and placebo were provided in dated containers labeled only A and B. The powders were mixed with the liquid and administered to the appropriate groups by school personnel. Throughout the entire experiment every possible precaution was taken to pre-

control group, but not in the experimental group. No significant changes were found for the digit span test.

Table 4 presents the comparison of changes in experimental and control group mean scores. The experimental group showed slightly greater gain in I.Q. and tapping rate and smaller gain in Cornell-Coxe performance than the control group, but differences were not significant. The only significant differences between the gains made by the two groups were found in coordination test scores, where the slower and more accurate performance of the star-tracing task by the control group is significantly different from the performance of the experimental group.

For comparison with individual data presented by Zimmerman and collaborators, Table 5 presents the gains in I.Q. for the 3 individuals in each group showing maximum gain.

TABLE 5
GAINS IN I.Q. FOR THREE INDIVIDUALS IN EACH GROUP
SHOWING MAXIMUM GAIN FROM 9/47 TO 6/48

Experimental group				Control group			
Sub- ject	I.Q. 9/47	I.Q. 6/48	Gain	Sub- ject	I.Q. 9/47	I.Q. 6/48	Gain
Em	74	95	21	Ma	57	76	19
Bu	51	62	11	Mo	51	68	17
Cu	44	55	11	El	63	75	12

The results presented above provide strong support for the hypothesis that controls in Zimmerman's experiment were inadequate. Our control group showed significant gains in I.Q. that did not differ significantly from those in the experimental group. The present experiment gives no evidence concerning the cause of these gains, but it may be suggested that a bias in test scoring, which was apparently not controlled in the earlier experiment, may have been operative. In the Indiana study another variable may be mentioned. The teachers at the school were greatly interested in the experiment. Consequently, the stereotyped institutional life of the subjects was very probably livened up by extra attention. The subjects in both groups also made two trips a day to the school kitchen. This additional stimulation may have produced some effect on test scores. Zimmerman and his collaborators do not report their procedure in sufficient detail to indicate whether extra stimulation was present in their study.

The mean gain in I.Q. reported for the retarded group in the Zimmerman study was greater than in the present one. However, when gains in the retarded group are corrected for regression as estimated, they are approximately the same as were found in the Indiana experimental group. It seems likely that, if bias affects test scores, the effect would be greater in the Zimmerman experiment provided we can assume that the psychometrists knew that the subjects were receiving glutamic acid. In the Indiana experiment the psychometrists knew that only half the subjects were receiving this treatment.

Although extreme gains in individual scores are not acceptable evidence when variable measures are used, it is of interest, though not surprising, that gains comparable to those reported in the appendix to Zimmerman's study were also found in the Indiana study (Table 5). Comparable extreme gains appear in both the experimental and the control groups.

The significant difference in time taken for star-tracing in the coordination test is in apparent agreement with animal studies (1, 2), which have shown greater activity following administration of glutamic acid. The significantly poorer error performance of the experimental group is probably related to the difference in time.

If tapping rate may be considered a measure of maximum rate of response, it is of interest that this was not significantly different in the two groups.

References

1. HAMILTON, H. C., and MAHER, E. B. *J. comp. physiol. Psychol.*, 1947, **40**, 463.
2. MARX, M. H. *J. comp. physiol. Psychol.*, 1949, **42**, 313.
3. ZIMMERMAN, F. T., BURGEMEISTER, B. B., and PUTNAM, T. J. *Psychosom. Med.*, 1947, **9**, 175.

The Measurement of Radioactive Hydrogen in Solid Samples—Comparison with Gas Counting¹

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Radioactive hydrogen has been measured as hydrogen gas, or a volatile compound containing hydrogen, inside Geiger-Müller counters and ionization chambers (1, 2, 4, 6). The experiments reported below demonstrate that solid compounds, suitably plated out on a sample pan and using a windowless counter, can be measured with satisfactory precision. The principal disadvantage of the solid-counting procedure arises from the extremely weak energy of the β particles emitted by radioactive hydrogen, leading to an infinite thickness of less than one mg/cm². The most important advantage is the elimination of the time-consuming steps in the gas-counting measurement: the quantitative combustion of the sample and complete conversion² of the resulting water into hydrogen gas. Additional time is consumed in the preliminary "seasoning" of the combustion-conversion train to avoid isotopic contamination. Further, the compound is not destroyed during the analysis. Consequently, it is expected that solid-counting techniques will be a valuable complementary tool in radioactive hydrogen tracer studies, including paper chromatographic and radioautograph techniques.

The compound selected for study of solid-counting was methyl-3- α -acetoxycholesterol containing radioactive hydrogen in the 11 and 12 positions. This compound, obtained in the course of a steroid tracer project, was made by the hydrogenation of the $\Delta^{11,12}$ cholestenate in an acetic acid medium containing radioactive hydrogen, with the use of a platinum oxide catalyst. It was purified by repeated addition and removal of inactive solvent and was recrystallized three times from petroleum ether (60° C). The melting point was 134.5° C.

The solid was directly plated on aluminum pans having an area of approximately 10 cm². A solution of the

¹ This project is jointly supported by the Office of Naval Research Contract #N6-ori-99, T.O.I., and the Atomic Energy Commission.

² Incomplete conversion results in isotopic fractionation and leads to incorrect analyses.

compound in acetone was added to the pans, which were then placed on a steam-heated plate. During this evaporation step the solution was spread over the entire surface by means of a glass rod scrubber. After the compound had separated out in a fairly uniform thin layer, the traces adhering to the side of the shallow pans were carefully removed.

The plated pans were placed in a positioned slot under a windowless methane-flow type counter operating in the proportional region.⁵ The background count was approximately 50 cpm and was measured either before or after each point plotted in Fig. 1.

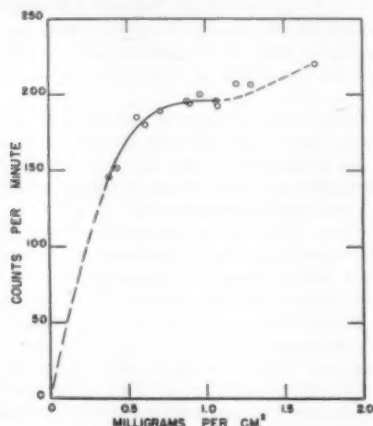


FIG. 1. Counting rate vs. thickness of sample. Solid-counting curve for methyl-3- α -acetoxycholesterol (radioactive hydrogen in the 11 and 12 positions).

The counts per minute, corrected for background, are plotted in Fig. 1 as a function of the mg of steroid/cm². After the initial rapid rise there is a leveling off between 0.8 and 1.1 mg/cm². Beyond this thickness and up to at least 1.7 mg/cm², the observed counting rate slowly rises. The 5 points that correspond to thicknesses between 0.8 and 1.1 mg/cm² average 195.4 cpm, with an average deviation of 1.9, or about 1%.

The probable error in each point caused by the statistics of counting is less than 0.7%. This represents a "practical" infinite thickness counting rate.⁴ This interval would be recommended for quantitative determinations of relative activity of the solid compound. Larger crystal formation is observed in the thicker samples, resulting in a slightly augmented or "corrugated" surface and leading to the slow increase in observed counting rate.

Libby (7) has given the following empirical range-energy relation for energies up to 200 kev:

⁵ The Radiation Counter Laboratory, Chicago, Illinois, Nucleometer. At the present time, windowless, flow-type counters functioning as Geiger-Müller and proportional counters are made by several companies.

⁴ For accurate knowledge of infinite thickness, the smoothness of the surface becomes increasingly significant when extremely weak β particle emitters are studied. The thickness is usually stated in terms of mg/cm², and the area used is the area of the supporting pan.

$$\text{Range (mg/cm}^2\text{)} = \frac{E^{2/3}}{150}$$

where E is the upper energy limit in kiloelectron volts. This equation shows a satisfactory agreement with data using monochromatic electron beams (8). Curran, Angus, and Cockcroft (3) have recently studied the β -ray spectrum of radioactive hydrogen and have reported an upper energy limit of 17.9 ± 0.3 kev. When this value is substituted in the equation, a calculated range of 0.82 mg/cm² is obtained. This is in qualitative agreement with the experiments reported here. At this value of the thickness, the counting rate in Fig. 1 has reached a level-off value.

A comparison of the solid-counting data reported above was made with the highly efficient internal gas-counting method. Several 5-mg samples were combusted, and the water completely converted to hydrogen over zinc at 400° C.⁵ The counter tube filling mixture contained 5 cm of hydrogen and 60 cm of methane. The upper portion of the proportional region was used with an amplifier-sealing circuit combination at a discriminator setting of one mv (5). The counting efficiency in the sensitive region is very close to 100%. Relative activities obtained in internal gas-counting are reliable to within 1%. The absolute disintegration rate was calculated to be $950 \pm 5\%$ disintegrations/min/mg steroid, or $7,600 \pm 5\%$ for 8 mg. It is seen in Fig. 1 that an 8-mg sample spread out on a 10-cm² pan has approximately reached infinite thickness and furnished an observed counting rate of 195 counts/min. In other words, the observed counting rate from this infinitely thick solid sample measured at close to 50% geometry is only 0.026 of the absolute disintegration rate for 8 mg of this steroid sample.

This comparison of gas- and solid-counting illustrates the complementary nature of each method in biochemical studies. The synthetic steps leading to the preparation of the labeled compound are, in general, carried out at higher specific activity levels in order to compensate for subsequent dilution in metabolic experiments. Solid-counting techniques will be primarily useful here. The extent to which solid-counting can be used to follow the activity of products of metabolism experiments depends, of course, on the extent of dilution. The gas-counting procedures will be generally applicable.

References

1. ALLEN, M. B., and RUBEN, S. *J. Amer. Chem. Soc.*, 1942, **64**, 948.
2. BLACK, J. F., and TAYLOR, H. S. *J. chem. Phys.*, 1943, **11**, 395.
3. CURRAN, S. C., ANGUS, J., and COCKCROFT, A. L. *Phil. Mag.*, 1949, **40**, 53.
4. EIDINOFF, M. L. *J. Amer. Chem. Soc.*, 1947, **69**, 2504, 2507.
5. ———. To be published.
6. HENRIQUES, F. C., JR., and MARNETTI, C. *Ind. eng. Chem. anal. ed.*, 1946, **18**, 420.
7. LIBBY, W. F. *Ind. eng. Chem., anal. ed.*, 1947, **19**, 2.
8. RUTHERFORD, E., CHADWICK, J., and ELLIS, C. D. *Radiations from radioactive substances*. New York: Cambridge Univ. Press, 1930. Chap. 14.

⁵ The combustions and conversions were carried out by Robert W. Jaller, Division of Steroid Biochemistry, Sloan-Kettering Institute.

A Maternal Influence on the Incorporation of Methionine into Liver Protein¹

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It was previously demonstrated (3) that two highly inbred strains of rats, differing in body size and growth rate, incorporated labeled S³⁵ DL-methionine into surviving liver-slice proteins at significantly different rates. In studying the mode of inheritance of this character, earlier observations have been confirmed and extended to a demonstration of the influence of maternal genotype on the process *in vitro* under foster nursing.

The results were obtained by the technique of Melchior and Tarver (2). According to this procedure, the labeled protein, *in vitro*, is freed of adsorbed radioactivity and the cyst(e)ine sulfur separated as the cuprous mercaptide. The remaining (methionine) sulfur is converted to sulfate, precipitated as benzidine sulfate, counted, and titrated. Results are expressed as % replacement, defined as the fraction of the methionine recovered which was replaced by radioactive methionine.

The foster-nursing tests were conducted on four litters of J (Fisher Strain No. 344) and four litters of F (Wistar King Albino) progeny, interchanged between mothers 12-36 hr after birth. The fostered offspring were weaned at 4 weeks and continued on stock diet of Purina chow and greens until they were sacrificed at 100-g body weight. Triplicate tests were performed on individual foster-nursed and control animals, and the results are summarized in Table 1.

TABLE 1

INFLUENCE OF FOSTER NURSING ON PROTEIN SYNTHESIS
in Vitro IN RAT LIVER SLICES

Litter No.	J ♂ nursed by F		F ♂ nursed by J	
	No. of tests	% Replacement	No. of tests	% Replacement
1	2	0.41	3	0.59
2	3	0.42	2	0.46
3	3	0.44	3	0.41
4	3	0.37	3	0.41
Average	11	0.41*	11	0.46
Standard error		± 0.02		± 0.03
Normal controls	12	0.29	10	0.43
Standard error		± 0.02		± 0.02

* Significantly different from normals at 1% level.

It is apparent that the maternal influence, acting through the milk, has stimulated the liver activity of the J strain to the level of the foster parent. The maternal

¹ This work was aided, in part, by a research grant from the American Cancer Society.

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TABLE 2
INFLUENCE OF FOSTER NURSING ON GROWTH

	No. of animals	Weight in g at end of weeks		
		4	8	10
J ♂ nursed by F	17	67	200	244
J ♂ " " J	185	55	170	212
F ♂ " " J	15	66	194	230
F ♂ " " F	167	66	184	232

influence on liver activity is accompanied by a marked increase in the growth of the fostered J progeny. It is also noticeable that the failure of F progeny to respond to J maternal influence on liver activity is reflected in the undisturbed growth of these animals, as shown in Table 2.

The demonstration of genetic control of the incorporation of an amino acid into the protein of liver tissue under the conditions of this study, and of the strong maternal (milk) influence on its hereditary transmission, raises certain questions concerning the generality of the phenomenon. It is to be wondered whether milk influence on specific metabolic processes in the mammal is part of a normal developmental mechanism. In this regard, the improvement of suckling ability and the elimination of cannibalism by vitamin B₁₂ supplementation to the diet of pregnant mothers (1), and the correction of developmental deformities by riboflavin supplementation to the diet (4), show the gross effect of maternal nutritional deficiency on normal development. The results of this study extend the effect of variable maternal potency to normal metabolic processes and development.

References

1. LEPKOVSKY, S. Personal communication.
2. MELCHIOR, J., and TARVER, H. *Arch. Biochem.*, 1947, **12**, 301.
3. RUTMAN, R. J., DEMPTSTER, K., and TARVER, H. *J. Biol. Chem.*, 1949, **177**, 491.
4. WARKARY, J., and SCHAFFENBERGER, E. *J. Nutrition*, 1944, **27**, 477.

Phenylhydrazine Oxalate as "Trapping Agent" for the Simultaneous Fixation of Intermediate Products in Lactic Acid Fermentation with Living Cells

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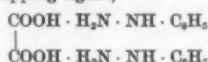
The chemistry of lactic acid fermentation is still based upon that of glycolysis because of the difficulties encountered in separation of the intermediate products which, on the contrary, was rather easy in the case of the cells of yeast and animal tissues.

Phosphorylation was, however, observed by Virtanen (16, 17), and Neuberg and Kobel (6) obtained a high

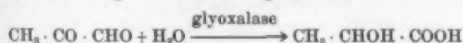
yield of methyl glyoxal by the reaction of hexose diphosphate with special enzymatic preparations of *Lactobacillus delbrückii*; the same lactobacillus converts the hexose diphosphate to lactic acid (14). As methyl glyoxal was excluded as a key intermediate product in biological processes, it was to be expected that the lactic acid fermentation would follow the pattern of glycolysis, according to the usual scheme of Embden-Meyerhof. However, research in this field is still limited, and no decisive results were obtained in the identification of the intermediate products. It is known, however, that *L. delbrückii* converts phosphoglyceric acid to pyruvic acid (2-6, 9), and this to acetyl phosphate (4).

Virtanen *et al.* (18) were unable to fix pyruvic acid in the presence of bisulfite from lactic acid fermentations, while Simon (10) and Neuberg and Kobel (7, 8) have questioned the fixation of the same acid and methyl glyoxal in the presence of semicarbazide according to the experiments of Kostytchew and Soldatenkow (3). Also, the results obtained with other bacteria are favorable to the applicability of the Meyerhof scheme to bacterial dissimilations. Stone and Werkman (13) found phosphoglyceric acid as an intermediate in some bacterial dissimilations. The triose phosphate dehydrogenase of *Escherichia coli* was studied by Still (12), and Utter and Werkman (15) compared the enzymes aldolase and isomerase of *E. coli* with those in muscle and yeast.

But a direct demonstration of the applicability of the Meyerhof scheme to the activity of lactic acid ferments could be obtained only by isolating the principal intermediates of dissimilation—for instance, the triose phosphates and pyruvic acid. Using phenylhydrazine oxalate (OP) as trapping agent,



I was able to fix both products simultaneously in fermentations with living cells, as was possible in alcoholic fermentations (1). The simultaneous isolation of triose phosphates and pyruvic acid suggests that the sequence of reactions that leads to the formation of lactic acid is the same as the Embden-Meyerhof scheme for glycolysis, i.e., the reduction of pyruvic acid to lactic acid involves an oxidation-reduction between triose phosphates and pyruvic acid. The complete absence of methyl glyoxal in the medium gives additional evidence that lactic acid cannot arise according to the following reaction:



Moreover, acetaldehyde was fixed, although the bacilli produced lactic acid from saccharose in a 95% yield. Considering that the bacilli are able to convert pyruvic acid mainly to acetic acid and 2,3-butylene glycol (unpublished results), the conclusion could be drawn that the fixed aldehyde is an intermediate of the degradation of pyruvic acid to acetic acid, via acetyl phosphate (4), followed by the conversion of acetic acid to 2,3-butylene glycol via acetaldehyde; a reaction perhaps like that which Slade and Werkman (11) observed for *Aerobacter aerogenes*.

The cells of a particular thermophilic strain of *L. delbrückii*, which I isolated recently, were grown on a medium containing beet molasses with up to 5% saccharose. After 20-hr incubation at 50° C with CaCO_3 , the cells were harvested by centrifugation, washed, re-centrifuged, and suspended in the fermentation mixture consisting of: yeast water, 700 ml; distilled water, 300 ml; saccharose, 10 g; Na_2HPO_4 , 3 g; salt (OP), 2 g; wet microbial cells, 15-30 g. Salt (OP) was dissolved in boiling yeast water; then the solution was cooled and saccharose was dissolved in it. After 6-hr incubation at 50° C, the medium was centrifuged and the fixed products were identified in the clear supernatant.

Acetaldehyde was determined by distillation of the medium with pyruvic acid in a Vigreux column and precipitation in the distillate as 2,4-dinitrophenylhydrazones (2,4-DNP), mp 164° C. Calculated: N%, 25.0. Found: N%, 25.10. Found: amount in g%/100, 0.005-0.01. Blank test: Distillation of the OP salt with pyruvic acid gives no acetaldehyde 2,4-DNP.

TABLE 1
METHYL GLYOXAL 2,4-DNP IN 100 ML DISTILLATE

Exp. No.	Without H_2SO_4	With 20% H_2SO_4
1	1 mg	14 mg
2	traces	28 mg

Pyruvic acid can be isolated as phenylhydrazone by ether extraction of the medium concentrated 1:5, or by precipitation as 2,4-DNP from the medium, concentrated and reacting at high temperature with benzaldehyde. The product is dissolved in $\text{N}/2\text{NaOH}$ and reprecipitated by acidification with HCl and recrystallization from acetic acid, mp 220° C. Calculated: N%, 20.89. Found: N%, 20.96. Found: about 0.15 g% as 2,4-DNP.

Trioses have been isolated as methyl glyoxal according to the method of Neuberg *et al.* (5), which was conveniently modified as in the preceding work (1), i.e., the medium, treated with benzaldehyde and extracted with ether, was distilled after addition of concentrated H_2SO_4 , so as to obtain a sulfuric acid concentration of 20%. Methyl glyoxal was precipitated in the distillate as 2,4-DNP, and this purified by dissolving twice in nitrobenzene and precipitating with alcohol, mp 298° C. Analysis: Calculated—C, 41.64; H, 2.77; N, 25.93. Found—C, 41.80; H, 3.02; N, 25.98. Found: 0.15-0.2 g% as 2,4-DNP. As the distillate from the fermentation mixture, not acidified with sulfuric acid, contains but traces of methyl glyoxal, it follows, as shown in Table 1, that the intermediate products are really trioses, not methyl glyoxal.

As was previously observed in alcoholic fermentation (1), the OP salt fixes mainly the first intermediates of fermentation and only by accelerating the microbial activity is it possible, probably for kinetic reasons, to fix the last intermediates in greater amount.

At the end of every experiment the positive vitality of the cells was tested by separate subcultures. The state of the trioses, i.e., whether they were or were not phos-

phorylated, was not investigated in the course of this research.

References

1. BOLCATO, V. *Nature*, Lond., 1950, **165**, 814.
2. KATAGIRI, H., and MURAKAMI, S. *Biochem. J.*, 1939, **33**, 1257.
3. KOSTYTSCHEW, S., and SOLDATENKOW, S. *Z. physiol. Chem.*, 1927, **168**, 124.
4. LIPMANN, F. *J. biol. Chem.*, 1944, **155**, 55.
5. NEUBERG, C., et al. *Biochem. Z.*, 1917, **83**, 263.
6. NEUBERG, C., and KOBEL, M. *Biochem. Z.*, 1929, **207**, 232.
7. *Ibid.*, 1927, **191**, 472.
8. *Ibid.*, 1928, **199**, 230.
9. *Ibid.*, 1933, **260**, 241.
10. SIMON, E. *Biochem. Z.*, 1932, **245**, 488.
11. SLADE, H. D., and WERKMAN, C. H. *Arch. Biochem.*, 1943, **2**, 97.
12. STILL, J. *Biochem. J.*, 1940, **34**, 1374.
13. STONER, R. W., and WERKMAN, C. H. *Biochem. J.*, 1937, **31**, 1516.
14. TYCHOWSKI, A., and KOBEL, M. *Biochem. Z.*, 1929, **209**, 134.
15. UTTER, M. F., and WERKMAN, C. H. *J. Bact.*, 1941, **42**, 665.
16. VIRTANEN, A. I. *Z. physiol. Chem.*, 1924, **138**, 136.
17. *Ibid.*, 1925, **143**, 71.
18. VIRTANEN, A. I., KARSTRÖM, H., and BÄCK, R. *Z. physiol. Chem.*, 1926, **151**, 232.

The Experimental Feeding of Parathion to Dairy Cows¹

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The increasing use of parathion (O,O-diethyl, O,p-nitrophenyl thiophosphate) as an insecticide on forage crops has resulted in speculation as to its excretion in the milk of dairy cows fed residual amounts of the chemical. Consequently an experiment was designed to determine the presence or absence of parathion in the milk of dairy cows fed parathion in capsules.

Ten dairy cows in heavy lactation, and representing the Ayrshire, Jersey, Guernsey, and Holstein breeds, were divided into two groups and fed commercially available parathion in the form of a 25% wettable powder (analysis: 23.75% parathion) continuously for 81 days. Cows in one group were fed parathion in capsules at the level of 5 ppm of an estimated roughage dry matter intake of 2.25 lbs/100 lbs of body weight daily. Cows in the other group were fed parathion in capsules at a level of 1 ppm of the estimated roughage dry matter intake. The two feeding levels were equivalent to 0.11 mg of parathion per kg of body weight for the 5-ppm group and 0.02 mg of parathion per kg of body weight for the 1-ppm group. These feeding levels represent an intake of parathion greater than that which would be in-

gested as residues (less than 1 ppm) on forage crops treated with amounts of parathion necessary for good insect control (3, 5). In order to study the effect of feeding parathion to cows in late lactation, an Ayrshire cow in late lactation was added to each of the above groups. These cows were fed parathion for only 2 weeks, at which time they were turned dry.

At the end of 81 days, all but 2 cows in the 5-ppm group were dropped from the experiment. At this time, the 2 remaining cows were administered parathion in amounts that were doubled each successive week until a parathion intake equivalent to 40 ppm of the roughage dry matter had been fed. At this final level they were receiving 0.88 mg of parathion per kg of body weight daily.

Samples of carefully mixed milk were taken on alternate days for 6 days prior to the beginning of the experiment and then on alternate days for 6 days subsequent to the beginning of parathion feeding, after which samples were taken at semiweekly intervals for 3 weeks. Thereafter, samples were taken once a week for the duration of the experiment.

Application of the sensitive colorimetric method of Averell and Norris (1) for the estimation of small amounts of parathion was tried on 100-g samples of milk, to which known amounts of parathion were added, and extraction attempts were made using the methods developed by Schechter et al. (4) and Carter (2). The presence of interfering substances and a very low recovery of the parathion added to the milk did not permit the use of either of the extraction methods. The difficulty seemed to lie with the development of a selective extraction procedure that could be used to separate the parathion from the milk. Upon the suggestion of the American Cyanamid Company, a procedure involving the use of a liquid-liquid extraction apparatus was tried; essentially this method involved a prolonged percolation of petroleum ether through a column of milk and ethyl alcohol. The mixture in the extraction chamber was stirred at 1/4-hr intervals with a wire stirrer inserted through the reflux condenser. Standard curves were prepared from data obtained from analyses of milk to which were added known amounts of parathion. Amounts ranging from 20 to 120 µg were added to 100-g samples of milk. The liquid-liquid extraction procedure was carried out for an optimum period of 6 hr, followed by the concentration of the petroleum ether and analysis by the Averell and Norris method. The percentage transmittance values were obtained using a wavelength setting of 555 mµ with a Coleman Model 14 spectrophotometer. It was found that milk blanks varied from 95% to above 100% transmittance when compared with the reagent blanks; therefore, in the actual analyses, no reading above 90% was considered significant. Technical petroleum ether (Skelly-solve "B") was used in all the analyses, since it was found that the use of purified petroleum ether did not improve the results. The use of 95% ethyl alcohol and distilled water to dissolve the residue remaining after the evaporation of the petroleum ether extract prevented the for-

¹Contribution No. 571, Department of Entomology, and No. 191, Department of Dairy Husbandry. This work was supported in part by a grant of funds and equipment from the American Cyanamid Company. The details of this experiment will be published in the near future.

mation of a bothersome turbidity that developed when benzene was used. Any slight turbidity appearing upon the addition of water to the solution of the residue dissolved in ethyl alcohol either disappeared during the reduction process or was removed by filtration.

Approximately 250 separate analyses were made during the course of the experiment. At no time was any parathion found in the milk from any of the cows fed parathion. Biological assays of the milk from the parathion-fed cows, using adult houseflies (*Musca domestica* L.) were conducted, and the absence of mortality among the flies served to confirm the negative analytical findings. No objectionable flavor was noted in the milk of the cows fed parathion, and no harmful effects to the health of the cows have been observed.

References

1. AVERELL, P. R., and NORRIS, M. V. *Anal. Chem.*, 1948, **20**, 753.
2. CARTER, R. H. *Anal. Chem.*, 1947, **19**, 54.
3. GINSBURG, J. M., et al. *J. econ. Entomol.*, 1949, **42**, 602.
4. SCHECHTER, M. S., POGORELSKIN, M. A., and HALLER, H. L. *Anal. Chem.*, 1947, **19**, 51.
5. *Tech. Bull. No. 2*. New York: American Cyanamid Company, 1948.

A Rational Method for Calculating Colloid Osmotic Pressure of Serum

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The usual equation for calculating the osmotic pressure of a solution is:

$$\pi = CRT \quad (1)$$

in which π is the osmotic pressure, T is the absolute temperature, R is the ideal gas constant, and C is the concentration of the solution in moles of solute per liter.

Capillary endothelium is a dialyzing membrane permeable to ordinary ions but not to a colloid or its ion. Within the capillary is blood serum, and outside of it is interstitial fluid.

The symbols y and $y+s$ are respectively the sum of nonprotein anion and cation normalities in blood serum, and x the same for interstitial fluid. The normality of the serum protein is z , and a its valence. According to the Donnan equilibrium relation (4),

$$x^a = y(y+s). \quad (2)$$

Because of the complexity added by consideration of bivalent ions (9), their low concentration, and consequently, the small scale of their effect, we omit them from this discussion. The observed pressure of equilibrium is the difference between the total osmotic pressures of the two solutions (10), or

$$\pi = RT(s+s/n+2y-2x). \quad (3)$$

¹The suggestion of this problem by Joseph B. Kirsner is gratefully acknowledged. This paper was written while the author was with the Frank Billings Medical Clinic, Department of Medicine, University of Chicago.

The symbol π represents in equation (3) what is generally called the colloid osmotic pressure. Putting the expression for x obtained from equation (2) into (3), we have

$$\pi = RT[s+s/n+2y-2\sqrt{y(y+s)}]. \quad (4)$$

Since albumin and globulin are the components of serum protein, let

$$s = s_A + s_G,$$

where s_A is the molarity of albumin and s_G the same for globulin. If the law of partial pressures applies,

$$\pi = RT[s_A/n + s_G/n + s_A + s_G + 2y - 2\sqrt{y(y+s_A+s_G)}]. \quad (5)$$

In order to use equation (5), molecular weights for globulin and albumin as determined by ultracentrifugation (2, 3, 5, 16) may be utilized, choosing 70,000 for albumin and an average value of 165,000 for globulin. Because protein is a titratable anion, it has been possible to determine the amount of alkali necessary to neutralize a specimen of serum protein when the pH of the medium is known (14).

The above information is used to formulate the expression for Z below. Let

A = g of albumin per 100 ml of serum,

G = g of globulin per 100 ml of serum,

pH = serum pH,

$[\text{HCO}_3^-]$ = mEq./l of serum bicarbonate,

$[\text{Cl}^-]$ = mEq./l of serum chloride,

T = temperature in $^{\circ}\text{C} + 273$,

$R = 0.849$ liter-mm H_2O /millimole- $(^{\circ}\text{C} + 273)$,

and

organic acid (in serum, assuming its acidity due to univalent carboxyl groups)

$$= 6 \text{ mEq./l } (7).$$

Define

$$Y = 0.849([\text{HCO}_3^-] + [\text{Cl}^-] + 6) \quad (6)$$

and

$$Z = 1.0614(\text{pH} - 5.16) + 0.654G(\text{pH} - 4.89). \quad (7)$$

Then, if P is the colloid osmotic pressure of the serum, we have

$$P = T[0.1212A + 0.0514G + Z + 2Y - 2\sqrt{Y(Y+Z)}]. \quad (8)$$

Equations (6), (7), and (8) stand in distinction to previously proposed empirical relations derived from curve fitting of a set of experimental data (1, 6, 8, 12, 17, 18). Scatchard (15) attempted a theoretical derivation, but made an erroneous substitution invalidating his result.

The impression exists that, in order to make a colloid osmotic pressure determination, a direct measurement with an appropriate osmometer should be carried out. To show that for clinical purposes this is not necessary, colloid osmotic pressures calculated with equations (6), (7), and (8) are compared with measured ones in Fig. 1.

If the effect of $[\text{HCO}_3^-]$ and $[\text{Cl}^-]$ on serum colloid osmotic pressure is known, the effect of serum sodium may readily be determined from the following equation:

$$1.178Z + [\text{HCO}_3^-] + [\text{Cl}^-] = [\text{Na}^+] + 4, \quad (9)$$

remembering the normal concentrations of the more dilute ions, as well as the original omission of consideration of

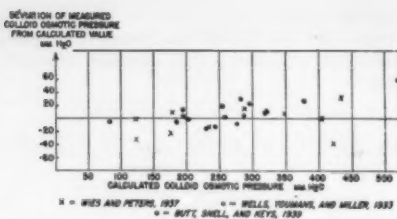


FIG. 1.

bivalent ions from the derivation of (6), (7), and (8). It is obvious that serum sodium varies in the same direction as does $[\text{HCO}_3^-] + [\text{Cl}^-]$ (or Y).

Taking the partial derivative of P with respect to Y in (8), it is found that

$$\partial P / \partial Y = T[2 - \{ \sqrt{Y} / (Y + Z) + \sqrt{(Y + Z) / Y} \}]. \quad (10)$$

It is obvious that $\partial P / \partial Y$ is always negative. In other words, an increase in Y always produces a decrease in P , and a decrease in Y always produces an increase in P .

It is to be noted then that, with all other factors remaining constant, a fall in serum sodium produces a rise in serum colloid osmotic pressure (Fig. 2). This is an

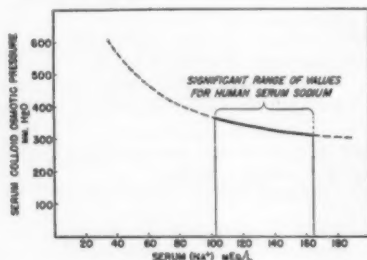


FIG. 2.

observation not previously emphasized and is a consequence of the Donnan equilibrium; it is discussed in more detail elsewhere (11). It is interesting in this connection that oral administration of isotonic sodium chloride has been shown to produce a fall in serum colloid osmotic pressure (13).

References

1. BJORNEBOE, M., BRUN, C., and RAASCHOU, F. *Nord. Med.*, 1947, **34**, 1465.
2. COHN, E. J. *Trans. Studies Coll. Phys. Phila.*, 1942, **10**, 149.
3. COHN, E. J., et al. *J. clin. Invest.*, 1944, **23**, 417.
4. DONNAN, F. G. *Z. Elektrochemie*, 1911, **17**, 572.
5. EDHALL, J. T. *Adv. protein Chem.*, 1947, **3**, 383.
6. VON FARCAS, G. *Z. ges. exp. Med.*, 1926, **53**, 666.
7. GAMBLE, J. L. *Chemical anatomy, physiology, and pathology of extracellular fluid*. Boston: Dept. Pediatrics, Harvard Medical School, 1942.
8. GOVAERTS, P. *Compt. rend. Soc. Biol.*, 1925, **93**, 441.
9. GREENBERG, D. M. In C. L. A. Schmidt (Ed.), *The chemistry of the amino acids and proteins*. Springfield: Thomas, 1938.
10. HOEBER, R. *Physical chemistry of cells and tissues*. Philadelphia: Blakiston, 1945.
11. KESSELMAN, R. H. To be published.
12. KEYS, A. *J. phys. Chem.*, 1938, **42**, 11.

13. MANKIN, H., and LOWELL, A. *J. clin. Invest.*, 1948, **27**, 145.
14. PETERS, J. P., and VAN SLYKE, D. D. *Quantitative clinical chemistry*. Baltimore: Williams and Wilkins, 1931. Vol. I.
15. SCATCHARD, G., BATCHELDER, A. C., and BROWN, A. J. *clin. Invest.*, 1944, **23**, 458.
16. SVEDBERG, T., and PEDERSON, K. O. *The ultracentrifuge*. Oxford: Clarendon Press, 1940.
17. WELLS, H. S., YOUNG, J. B., and MILLER, D. G. *J. clin. Invest.*, 1933, **12**, 1103.
18. WIES, C. H., and PETERS, J. P. *J. clin. Invest.*, 1937, **16**, 93.

Decreased "Hunger" but Increased Food Intake Resulting from Hypothalamic Lesions¹

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A marked increase in food intake, hypothalamic hyperphagia, regularly follows bilateral lesions in the region of the ventromedian nuclei of the hypothalamus. There is no corresponding increase in energy output; the result is obesity. These effects have been produced experimentally in the rat, cat, dog, and monkey; they have been observed as one of the effects of basal brain tumors in man (Froelich's syndrome, or dystrophia adiposogenitalis), and of spontaneous degeneration of the ventromedian nuclei in the mouse.

The literature relating to this problem has been summarized elsewhere (1, 6), but since effects of lesions in this area are not generally known they will be listed briefly here. In the rat the diurnal cycle of food intake disappears, being replaced by a relatively constant level. Resection of most of the stomach does not appreciably reduce the hyperphagia. The increased food intake and rapid weight gain (dynamic phase) are not indefinitely maintained; a weight plateau is reached in about 2 months, with food intake gradually falling to a more normal level (static phase). However, after fasting to normal weight, these animals will again show a hyperphagia on return to an ad libitum diet.

Discrete bilateral electrolytic lesions made with the Horsley-Clarke stereotaxic instrument have ruled out direct involvement of the pituitary. In the rat these lesions also cause a marked upset in water balance, as demonstrated by delay in release of water load, low ratio of water to food intake, and increased renal tubular reabsorption. An increased serum sodium in these animals suggests that a chronic state of relative

¹ This study was supported by the Institute of Human Relations, Yale University, the Fluid Research Fund, Yale University School of Medicine, and by Contract VAM 23379 of the Veterans Administration. The help of E. Haller and K. G. Ogren is gratefully acknowledged.

dehydration results from an inadequate intake of water, "hypothalamic hypodipsia" (7). Rage is more easily evoked in the cat and the rat, and gonadal atrophy usually occurs, but these effects do not always accompany obesity and may follow lesions of other hypothalamic areas that do not produce obesity.

The purpose of the present study was to determine whether the marked increase in food intake produced by this lesion is accompanied by increased performance in a variety of behavioral tasks motivated by hunger. Different tests were used in order to reduce the possibility that the operation affected the particular function employed as a measure of motivation rather than the motivation itself.

The following tests were used: rate of bar pressing reinforced by food at 5-min intervals, speed of running down a short alley to secure food, strength of pull exerted during temporary restraint on the way to food, amount of electric shock required to prevent approach to food, amount eaten when a weighted lid has to be lifted to get food, and amount eaten in spite of a bitter taste when quinine was mixed with the food. Because performance on these tests is known to increase with food deprivation (up to reasonable limits), it is assumed that they are behavioral measures of "hunger." Positive results on these measures would indicate that this lesion increases a general hunger drive, negative ones would suggest that it maintains hunger at a relatively constant low level or that it interferes with the mechanism of stopping eating.

Twenty-two hungry male albino rats of the Sprague-Dawley strain, weighing approximately 350 g, were first trained to press a bar to secure a small pellet of food. During the latter part of the training the food reinforcement was at 5-min intervals—that is, the food-delivering mechanism was reset every 5 min. Under these conditions rats respond at a steady rate, which increases progressively with the length of food deprivation up to 4 or more days (5). The animals were also thoroughly trained to wear a little harness and run down a short alley, at the end of which they pressed back a small metal shield to secure food. In this type of situation, the speed of running, strength of pull when temporarily restrained (2, 3), and amount of electric shock required to keep the animal from the goal (4) have been found to increase with food deprivation, and hence presumably with hunger.

After the preliminary training, the animals were divided in two matched groups: (a) 10 controls, 5 of which were anesthetized and had their skulls opened with a drill to simulate an operation; and (b) 12 animals that received bilateral lesions approximately 1 mm in diameter in the regions of ventromedian nuclei of the hypothalamus. The lesions were made with the Horsley-Clarke stereotaxic instrument. The coordinates used were those previously found to produce lesions in or near the lateral aspect of the ventromedian nuclei of rats of the same strain and size. The electrodes were insulated except at the tip, the current used was 2 ma for 15 sec. One of the operated animals died, 11 recovered to apparently good health. All animals were allowed food ad libitum except during the various tests.

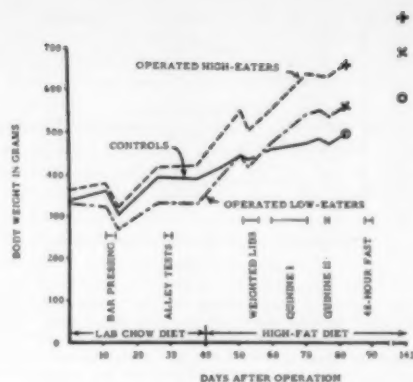


FIG. 1. Weights of different groups of rats when various tests were administered. During the first three types of tests, one of the operated subgroups was heavier and the other lighter than the unoperated controls. After the introduction of the high-fat diet, both operated groups gained more rapidly than the controls, so that by the end of the experiment even the Operated Low-Eaters were heavier than the controls.

Placed on a diet of dry, ground lab chow, 4 of the operated animals (to be called *Operated High-Eaters*) ate 30%–85% more than the average of the controls; 7 (*Operated Low-Eaters*) ate approximately the same or less than the controls. When a high-fat synthetic diet² was introduced on the 40th day after operation, the average food intake of the Operated Low-Eaters went above that of the controls, the difference being statistically significant ($p < .01$). These effects are reflected in the weight curves in Fig. 1, which also shows how long after the operation each type of test was given. It can be seen that during the bar-pressing and alley tests, the average weight of the Operated High-Eaters was above, whereas that of the Operated Low-Eaters was below, that of the unoperated controls. This gives us a way of ruling out the effects of weight on the test performance of the operated animals. After the high-fat diet was introduced, the weights of the operated animals increased markedly, so that even the Operated Low-Eaters became heavier than the controls ($p < .01$).

Bar pressing. On the 11th day after the operation the animals were thoroughly satiated on ground lab chow moistened with water and then immediately put in with the bar for a 20-min period. The number of times they pressed the bar was recorded. The same test was repeated at various intervals (up to 96 hr) during the fast. With the technique of periodic reinforcement, the amount of food each animal received (0.2 g per test) was negligible. The results are presented in Fig. 2. Immediately after satiation both operated groups pressed the bar less frequently to get food than did the controls.

² The high-fat synthetic diet yielded 5.8 cal/g, of which 60% was from fat, 20% from carbohydrates, and 20% from protein. It contained adequate amounts of all known accessory food factors required by the rat, including 4% by weight of a salt mixture.

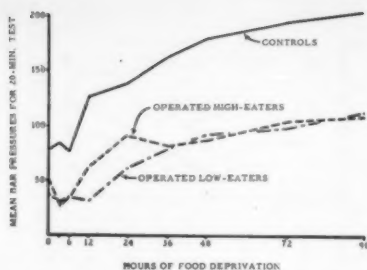


FIG. 2. Effect of hypothalamic lesions on the rate of bar pressing after various intervals of food deprivation. The rate of bar pressing (reinforced at 5-min intervals) increases with hours of food deprivation; the performance of both operated subgroups is poorer than that of the control rats. (Since one of the Operated Low-Eaters had a total score that was more than 12 S.D. above the mean of the rest of the operated group, his scores are omitted from this graph. They were, respectively: 141, 120, 123, 180, 220, 252, 229, 287, and 220. This is the only type of test on which this animal's scores were significantly different from those of the other operated animals.)

The rate of bar pressing by all groups increased with hours of food deprivation, but the increase of both operated groups was less than that of the controls. At each of the 9 points on the curve, the inferiority of the operated animals is highly significant statistically ($p < .01$).

Alley tests. On the 29th day after the operation the animals were satiated again and immediately afterward given 4 test trials in the alley without wearing harnesses. The average speed of the operated animals was slower than that of the controls, but the difference was not statistically reliable. After 72 hr of fasting the animals were given 2 additional trials with harness in the alley. Again the operated animals ran more slowly than the controls; this time the difference was fairly reliable ($p < .05$). Next their strength of pull was measured when they were temporarily restrained on the way to the food. The control animals pulled harder than the operated animals, and the difference was statistically significant ($p < .01$). Finally, the animals were given tests during which they received increasingly strong shocks from the metal shield covering the food. On the average the operated animals were stopped by lower values of shock than the controls, but the difference was not statistically significant.

Weighted lids. From the 40th day after the operation to the end of the study the animals were kept on a high-fat synthetic diet. On the 46th day light, hinged lids, concealing the food but easy to operate, were put on the food dishes in each rat's home cage. After 6 days of learning to operate the lids, a 75-g weight was put on the outer edge of the lid for half of both operated and control animals. After 3 days of testing, the weights were shifted for 3 days to the lids of the dishes of the animals in the other half of each group. Without weights on the lids, the operated animals ate more than the controls, the daily means being 21.2 and 16.3 g ($p < .01$). With weights on the lids, the total intake

of both groups was reduced, and the direction of the difference between them was reversed, the daily means being 3.3 g for operated and 10.8 g for controls ($p < .01$).

Quinine tests. In order to impose an entirely different type of "resistance" to eating, the lids were removed and the high-fat diet gradually made bitter by progressively adding more quinine to it each day from the 61st to the 70th day after operation. While the concentration of quinine was still relatively weak, the operated animals ate reliably more than the controls, the daily means being 26.4 and 15.1 g, respectively ($p < .01$). Increasing amounts of quinine decreased the intake until, by the 70th day, when the proportion was 1,024 mg of quinine per 100 g, the daily means were down to 2.8 and 8.8 g for the operated and control animals, respectively ($p < .01$). The use of this different kind of "resistance" to eating had again reversed the relative food intakes.

After 6 days' recovery on a bland, high-fat diet, all animals were returned to the 1,024 mg of quinine per 100-g diet mixture, and at various times, up to 48 hr after introduction of the bitter mixture, cumulative measures were taken of the total amount eaten. The results, compared with similar measures taken on bland food 9 days later, are presented in Fig. 3. It can be seen that under all conditions the eating continued at a reasonably regular rate, as indicated by the fact that the curves roughly approximate linearity. The rate of food consumption is greater for the bland than for the bitter mixture; with the bland mixture it is greater for the operated animals than for the controls, and with the bitter mixture this difference is reversed. All these differences are highly reliable ($p < .01$).

Forty-eight-hr fast. As a supplement to the behavioral tests, the effects of a 48-hr fast on subsequent food consumption were determined for various intervals up to 24 hr. On the 89th day after operation, food was taken away from all animals and then restored after 48 hr. Whereas before the fast the operated animals had been eating more than the controls, afterwards this difference was reversed during the period of observation ($p < .01$).

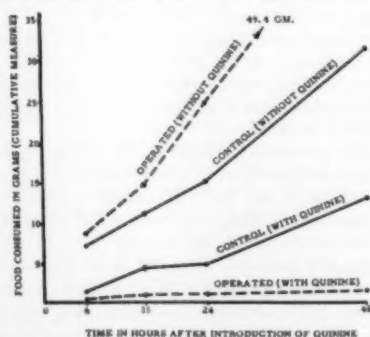


FIG. 3. Effect of a bitter taste on the food intake of rats with hypothalamic lesions. With a bland mixture of synthetic high-fat diet the cumulative curves show a higher food intake for the operated animals than for the controls; with a bitter mixture (1,024 mg of quinine/100 g) the food intakes of both groups are reduced, and the direction of the difference between them is reversed.

It should be noted that the operated animals were all considerably heavier than the controls by the time this fast was given.

In all the behavioral tests the operated animals performed more poorly than the controls, and in most instances the differences were clearly significant statistically. Because of the consistent results with such a variety of tests, it seems more plausible to assume that the operation interfered with hunger than to assume that it had specific effects on the different functions involved in each of the various tests.

While they were on a diet of ground lab chow, some of the operated rats ate consistently more than the controls, whereas others ate somewhat less. The performances of both operated groups were highly similar on the behavioral tests; both of them were poorer than the controls. The fact that one of the operated subgroups was heavier and the other lighter than the controls rules out the factor of body weight as an explanation for their inferior performance.

When placed on a high-fat diet, both operated groups ate consistently more than the controls in all ad libitum situations throughout the experiment. The reduced intake of the Operated Low-Eater subgroup or the less-well-liked ground lab chow diet seems to be analogous to the poorer performance of the operated animals on the behavioral tests.

One interpretation of the results of this study is that

the hypothalamic lesions cause the mechanism regulating hunger to "stick" at a relatively constant low level. This explanation would not be sufficient by itself, however, to account for the poor performance of the operated animals on bar pressing immediately after satiation. Another interpretation would be that the lesions interfere seriously with the mechanism of stopping eating and somewhat less seriously with the mechanism of hunger. Whatever the final explanation may be, the striking fact is that the measures of the amount of food eaten in ad libitum situations yielded results opposite to those of the tests where some form of work had to be done or "resistance" overcome. This suggests caution in drawing inferences about "drive" from consummatory behavior in both psychological and psychiatric studies.

References

1. BROBECK, J. R. *Physiol. Rev.*, 1946, **26**, 541.
2. BROWN, J. S. *J. comp. Psychol.*, 1942, **33**, 209.
3. ———. *J. comp. physiol. Psychol.*, 1948, **41**, 450.
4. MILLER, N. E. In Hunt, J. McV. (Ed.), *Personality and the behavior disorders*. New York: Ronald, 1944. Pp. 431-65.
5. SKINNER, B. F. *The behavior of organisms*. New York: Appleton-Century, 1938.
6. STEVENSON, J. A. F. *Recent progress in hormone research*. New York: Academic Press, 1949. Vol. 4, p. 363.
7. STEVENSON, J. A. F., WELT, L. G., and ORLOFF, J. *Amer. J. Physiol.*, in press.

Comments and Communications

"Funginert"—A Designation for Inherently Fungus-resistant Material

During and following World War II there has been increasing recognition of the importance of biological factors in the deterioration of engineering materials. Fungi and other microorganisms, already known to be destructive to products such as lumber and cotton textiles, were found to exert a malign effect also on electrical equipment, with resultant degradation and operational failure. In many cases damage was indirect, as when operational failure resulted from corrosion of a metal surface, caused in turn by metabolic products from fungi supported by an adjoining nutrient surface.

In attempts to prevent such damage, military and other specifications are now increasingly being phrased to require that materials used in equipment have resistance to fungus growth. For the kind of resistance that depends on fungistatic or fungicidal chemicals, the terminology and test methods for the chemicals and for the treated engineering materials may follow somewhat along the lines of the older parallel usages in medicine and agriculture. In other cases, however, materials are desired which have innately the property of not supporting fungus growth because of absence of nutrients rather than because of presence of fungistatic chemicals. Such

materials have been designated as "nutriently inert" or "not supporting fungus growth" in certain publications (Bureau of Ordnance Specification 52T15 (Ord). *Treatment, moisture- and fungus-proofing, of elements, components, and assemblies, electrical and electronic: general specifications*. 22 pp. Proposed draft, Feb. 14, 1947), which have also provided special test procedures by which this property of "nutrient inertness" might be demonstrated. With these inconveniently long terms it was still necessary to add modifying words to make the meaning precise.

As the concept discussed is applied more and more broadly (for example, to plastics, tape, transformers, and electrical insulated wires), it becomes desirable to designate it by a distinct and concise name. To fill this need, the coined words "funginert" for the adjective and "funginertness" for the characteristic are proposed. Definitions are:

Funginert. Not supporting fungus growth because the material, part, or component in question does not furnish the necessary nutrients for such growth. To be distinguished from both "fungistatic," which indicates presence of a chemical or physical agency that actively prevents growth of fungi, and "fungicidal," which indicates presence of an agency (usually chemical) that can kill

fungi—as in “Pyrex glass is funginert but not fungistatic.”

Funginertness. The characteristic of being funginert—as in “The funginertness of nylon-jacketed wire is permanent and not limited by the period of effectiveness of a somewhat instable fungistatic chemical.”

The new terms, being coined words, can cover precisely the desired total concept of fungus resistance because of absence of nourishment for the organism and not because of presence of fungistatic or fungicidal influences. A number of parallel words can obviously be formed—for example, “bacterinert” and “bacterinertness” or “microbinert” and “microbinertness” for cases in which it is desired to describe materials with reference to bacteria or to microorganisms in general.

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Quantum Theory and Phytoplankton Photosynthesis

In the first issue of *Hydrobiologia*, R. Maucha (*Hydrobiologia*, 1948, 1, 45) has a paper that would seem to represent an important application of quantum theory to ecology. However, a study of the mathematics contained in the paper reveals two erroneous assumptions that invalidate his work: (1) he assumes that a graph of photosynthesis against light intensity represents a sine function, and (2) he assumes that the phytoplankton photosynthesis system is a closed system.

It is well known that high light intensities inhibit photosynthesis in phytoplankton that are adapted to dim light. E. I. Rabinowitch (*Photosynthesis and Related Processes*, I. New York: Interscience, 1945) has a chapter on “Photautoxidation” in which light inhibition of photosynthesis is discussed in detail. The phenomenon is, however, so variable in different plants and in the same plant under varied conditions, that resemblance of such a graph to a sine curve is superficial and is not a reliable foundation for mathematical deduction. Maucha does not discuss photautoxidation, and it is not a variable in his equations.

Even if the graph were a sine function, Maucha's other error would still invalidate his deductions. That he assumes phytoplankton photosynthesis to be a closed system is emphasized by repeated attempts to demonstrate that the law of energy conservation is obeyed in the system. L. v. Bertalanffy (*Science*, 1950, 111, 23) has pointed out that living systems are not subject to the laws of closed system thermodynamics, and that the extension of these laws to open systems leads to very unexpected results. Maucha's analogy of a quasi-elastic resonating system that suffers an equilibrium shift proportional to the intensity of the applied impulse (light, in the photosynthetic system) leads him to the dubious

conclusion that intense light uses up the CO_2 inside the cell so rapidly as to reduce photosynthesis to zero. “*Ist nämlich die Lichtenergie viel zu gross, dann verringert sich c_g [the intracellular CO_2 concentration] schliesslich zu 0. . . die Photosynthese kommt zu einem Stillstand, wir haben mit inaktiver Lichtstärke zu tun.*” From equations based on these assumptions Maucha extracts a constant which, when multiplied by 10^{-27} , agrees closely with Planck's constant.

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Our Decelerating Planet

I was amused by C. A. Cotton's letter (*Science*, 1950, 111, 14) regarding the deceleration of the earth in a mere 56 million years. I do not doubt the accuracy of Dr. Cotton's position and arguments, but we have much more startling arguments regarding the earth's rotation seriously proposed in this country. For example, *Harper's* January issue indicates that there is sound and even scientific reason for believing that the earth stood still in Joshua's time, a mere 3,500 years ago, and that, *mirabile dictu*, it has regained its present momentum since that relatively recent date.

In case some scientists are inclined to dismiss *Harper's* lightly, allow me to explain that this magazine is very proud of its long literary record, that it does not hesitate to lecture scientists severely for their inability to write in good literary style—i.e., by *Harper's* fantastic standards. The present writer is willing to admit that no honest scientist can possibly compete on a literary basis with such startling proposals as may be found in the January number of that learned magazine. It appears that all objections based upon physical laws, biological principles, and historical facts are clearly and unequivocally overruled.

This article, “The Sun Stood Still,” is only one of the recent and startling revelations contained in this sedate magazine. Only last November, *Harper's* considerably improved on a recent U. S. Supreme Court decision. Apparently both the legal and scientific professions must look to their laurels, or their literary rivals, who benefit by a broad liberal education, will completely overshadow their achievements. Indeed, the advantages of a broad liberal education are such that in the near future we may expect all scientific advances of any significance to come from our poets and literary critics.

If Mr. Cotton and the editors of *SCIENCE* will merely read the January number of *Harper's*, they will discover how very old-fashioned is their concern over the deceleration of the earth from a 6¼-hour day to a 24-hour day in so long a time as 56 million years.

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Dr. Hess & Clark, Inc.
Ashland, Ohio

News and Notes

La Cinquantenaire de la Découverte du Radium and The Fifth International Cancer Congress, Paris

Shields Warren

*Division of Biology and Medicine, U. S. Atomic Energy Commission,
and AAAS Representative*

The 50th anniversary of the discovery of radium was celebrated July 16-21 at L'Ecole Supérieure de Physique et de Chimie Industrielles, in Paris, France. Approximately 150 distinguished research workers attended, and numerous excellent papers by American, French, English, Swedish, Danish, and other authors were read during the scientific sessions. The high light of the celebration was a special session of all official delegates on July 16, attended by both daughters of the Curies—Eve and Irene. Drs. Boreau and Broglie presented a eulogy of Pierre and Marie Curie at this session. As part of the ceremony, the library at the school was dedicated, with special emphasis on the field of radiation.

On the morning of July 16 the Fifth International Cancer Congress was opened in Paris in the presence of President Auriol of the Republic of France. Scientific sessions were held July 17-21 at the Sorbonne, with delegates from many nations, including the Soviet Union, attending. A. Lacassagne, of Paris, presided as president

of the congress and I. Millan, of Mexico, as president of the Executive Committee. Papers covering a wide range of subjects were read.

The principal subjects were cancers and hormones, induced cancers, cancers and virus, microorganisms in cancer, the cytology and histology of cancer, experimental chemotherapy, biochemistry, transplantable cancers, radiobiology, mutation, and protection against cancerogenic agents. Sessions focusing on the problems of cancer control, including statistical and other evaluations of the cancer problem, supplemented these meetings in the experimental field. In addition, the pathology of cancer of various portions of the body—particularly the skin, the respiratory passages, bone, tumors of the salivary gland, the breast, and uterine cancer—was given consideration.

All participants in the congress owe a debt of gratitude to Prof. Lacassagne and our French colleagues for the fine work they did in organizing and providing facilities for the congress.

Tenth International Ornithological Congress

Alexander Wetmore

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The Tenth International Ornithological Congress, held in Sweden by invitation of the Swedish Ornithological Society, was initiated during the first week in June by excursions based on the University at Lund, which gave opportunity to see the bird life and other natural features of the farming and forested country in southern Sweden, as well as to visit the Island of Gotthland. The formal meetings were opened June 10 in Uppsala, with Alexander Wetmore, secretary of the Smithsonian Institution, serving as president, and Sven Hörstadius, of the University of Uppsala, as general secretary. The headquarters of the congress were at the university in "Värmlands Nation," and the meetings were held in lecture rooms of the university and in an adjacent hall. About 350 persons, representing more than 25 countries, were registered. The official delegation from the U. S. included Herbert Friedmann, U. S. National Museum; Alfred O. Gross, Bowdoin College; Frederick C. Lincoln, Fish and Wildlife Service, U. S. Department of the Interior; Dillon Ripley, Peabody Museum (at Yale); J. Van Tyne, University Museum, University of Michigan; and A. Wetmore (chairman).

This was the first postwar meeting of the congress, the last having been held in Rouen and Paris, France, in 1938. Sessions of special interest were devoted to evolution and systematics, bird migration and orientation, bird behavior, population dynamics, and a round-table conference on bird ringing. The last-mentioned was of importance in integrating the banding schemes of the various countries where this work now goes forward. Presentations in motion pictures included the Takahe (*Notornis*) of New Zealand, for many years believed to be extinct, the recently discovered nesting of the bristle-thighed curlew in Alaska, birds of the Antarctic, and zoological travels in Nepal. There was much emphasis on studies in behavior, with a summary of recent advances by N. Tinbergen, and important contributions on inheritance and learning and other features in avian psychology. Other noteworthy studies concerned populations in several species, and modern findings on routes of migration.

Short excursions during the week were made to the town and country homes of the illustrious Linnaeus, to the forested country adjacent to Uppsala, and among

the islands on the eastern coast. The formal banquet was held in the imposing Great Hall of Vasa Castle on the hill overlooking the city. Following the formal meetings which closed June 17, long excursions centered on Abisko and Ammannä, gave opportunity to see the

ecological features and topography of far northern Swedish Lapland, with its interesting bird life.

It was voted to hold the next congress in 1954 in Switzerland, and A. Landsborough Thompson, of England, was elected president.

About People

D. C. Balfour, director of the Mayo Foundation, and **A. W. Allen**, chairman of the Board of Regents of the American College of Surgeons, have been appointed honorary fellows of the Royal College of Surgeons of Edinburgh.

Alexander Brunschwig, chief of the Gynecological Service at Memorial Center for Cancer and Allied Diseases, New York City, has been awarded a medal from the University of Brussels in recognition of his services to medicine and humanity. While in Belgium Dr. Brunschwig gave a series of lectures and surgical demonstrations at meetings of La Journée Médicale Bruxelloise.

Gustav Egloff, director of research, Universal Oil Products Company, Chicago, has been elected a fellow of the Royal Society of Arts of Great Britain.

Egon A. Hiedemann, international authority in acoustics and ultrasonic research, has been named head of the Department of Physics and Astronomy at Michigan State College. Dr. Hiedemann will replace **Thomas H. Osgood**, who became dean of the Graduate School in July. Dr. Hiedemann is at present professor of physics at Georgetown University, Washington, D. C., and part-time consultant for the Naval Ordnance Laboratory at White Oak, Md.

Daniel J. Holland has been appointed professor and director of the Department of Oral Surgery at Tufts College Dental School. Dr. Holland, who has been with the dental school since 1948, will hold the same positions in the New England Medical Center, for which Tufts is the teaching base.

J. Rud Nielsen, research professor of physics at the University of Oklahoma, will participate in a symposium of the Faraday Society at

Cambridge University, England, September 25-28.

He will speak on "Infrared and Raman Spectra of 1,3,5-Trifluorobenzene," a topic based on his work at the University of Oklahoma in cooperation with the Office of Naval Research and the Naval Research Laboratory at Washington, D. C.

Morris Pollard, who has completed a year of special research with K. F. Meyer, director of the Hooper Foundation for Medical Research at the University of California Medical Center, San Francisco, will resume his duties as associate professor of preventive medicine at the University of Texas Medical Branch and director of the Virus Research Laboratory in Galveston next month.

Charles L. Seeger, a member of Cornell University's radio astronomy staff since its origin in 1947, will join a similar project at Chalmers University of Technology in Gothenburg, Sweden, this month. The Swedish institution is engaged in investigation of the ionosphere, the aurora, and other areas of electron physics, and is building an observatory for radio astronomy work.

C. S. Shoup, professor of biology at Vanderbilt University, is on leave of absence to serve in the Biology Division of the Office of Research and Medicine, Atomic Energy Commission, Oak Ridge Operations.

Edmund M. Spicker, chairman of the Department of Geology at Ohio State University, has been appointed chairman of the Geology Panel of the Committee on Geophysics and Geography, Research and Development Board, Department of Defense. Dr. Spicker has been serving as alternate to the former chairman, **Walter Newhouse**, of the Department of Geology, University of Chicago.

Ernest S. Tierkel, assistant chief, Veterinary Public Health Branch, PHS Communicable Disease Center,

Atlanta, has been named to a five-year term on the World Health Organization's expert panel on rabies. In his new post, Dr. Tierkel will advise WHO headquarters of new research developments in the field of rabies in the United States.

Calvin O. Williams has been appointed executive secretary of Southwest Research Institute's International Division. Dr. Williams, formerly a staff member of the Institute of Inventive Research, an affiliated organization, is at present in Havana, as secretary of a technoeconomic mission sponsored by the International Bank for Reconstruction and Development.

Visitors

Dorothy M. Stone of Manchester, England, has been appointed Mary Whiton Calkins Visiting Professor of Mathematics at Wellesley College for the year 1950-51.

Recent visitors at the Communicable Disease Center, U. S. Public Health Service, Atlanta, Georgia, were **Alberto B. Aquilar**, director, Division of Epidemiology, Department of Health, San Salvador, El Salvador; **Victor A. Botto**, hospital director, Ministry of Public Health, Lima, Peru; **Hideo Fukumi**, director, Bacteriology Division, National Institute of Health, Tokyo; **George Kostassianis**, malaria inspector, Ministry of Hygiene, Athens, Greece; and **José B. Mendoza**, Malaria Control Section, Department of Health, Manila.

Twenty-four Philippine health workers will spend a year in the U. S. studying under fellowships established by the Philippine Rehabilitation Act, supervised by the Division of International Health of the USPHS. The trainees will observe public health administration techniques and do field work with national, state, and local health organizations before beginning courses in

the fall. Among those taking part in the program, and their special fields, are: **Gerardo L. Adan**, tropical disease, at Tulane University; **Josefina B. Barrios-Balea**, epidemiology, at University of North Carolina; **Concordia G. Bautista**, maternal and child care and public health education, at University of North Carolina; **Wigberto P. Clavecilla**, public health administration, at Harvard University; **Andrés Y. Cruz**, tuberculosis control, at Johns Hopkins University; **José Cuyegkeng**, bacteriology, at University of Michigan; **Lourdes R. Espiritu**, virology, at University of Pittsburgh; **José A. Florendo**, maternal and child health, at University of California, Berkeley; **David A. García**, hospital administration, at Columbia University; **Lauro S. García**, tuberculosis control, at Harvard University; **Emmanuel T. Gatchalian**, industrial hygiene, at University of Pittsburgh; **Florencia M. Herrera**, school health, at Yale University; **Ignacia de Jesús**, venereal disease control, at Columbia University; **Francisco R. José**, public health nutrition, at Harvard University; and **Marcelina F. Reyes**, public health dentistry, at University of Michigan.

Awards

The Sauveur Achievement Award for 1950, of the American Society for Metals, will be presented at the National Metal Congress in Chicago to Clarence E. Sims, assistant director, Battelle Memorial Institute, for his studies and research into the origin and effects of inclusions in cast steels.

The Association for the Study of Internal Secretions has made the following awards for 1950. **Squibb Award**, \$1,000 for work in endocrinology to C. N. H. Long, Sterling Professor of Biochemistry and dean of the Yale University School of Medicine. Dr. Long has been a leader in the development of understanding of the pituitary and adrenal glands, and his contributions have been an important stimulus to concepts of clinical diabetes, Cushing's syndrome, and many endocrine disorders. **Ciba Award**, \$1,200 to Oscar M. Hechter, of the Worcester

Foundation for Experimental Biology, and research associate in physiology, Tufts Medical School. Dr. Hechter has developed a new method for the introduction of oxygen into position 11 of steroids, which has furnished the first evidence for the presence of the enzymatic activity whereby certain hormones of the adrenal cortex are formed in the animal organism. **The Ayerst, McKenna and Harrison Fellowship** of \$2,500 was awarded to Lawrence E. Shulman, of Johns Hopkins Hospital, to permit him to pursue clinical investigations on the effects of ACTH and cortisone in states of hypersensitivity under the direction of John E. Howard and A. McGehee Harvey, and to carry out experimental studies with these hormones on anaphylaxis in animals under George Mirick. **The Schering Fellowship in Endocrinology**, \$2,500, was awarded for the second time to D. Laurence Wilson, of Peter Bent Brigham Hospital, to continue his work under the direction of George Thorn in the field of metabolic and endocrine diseases.

Meetings

The fall meeting of the **American Physiological Society** will take place at Ohio State University, September 13-16. Scientific sessions, demonstrations, and exhibits will be held in or near the College of Medicine (Hamilton Hall) and the new medical center. The Neil House is headquarters hotel for the meeting. The program comprises approximately 250 papers, 15 demonstrations, and 4 motion pictures. Members and friends of the society are urged to attend. For further information, address Dr. Fred A. Hitchcock, Chairman, Local Committee, Hamilton Hall, Ohio State University, Columbus 10.

Meeting of Biological Societies under Sponsorship of the American Institute of Biological Sciences. The Ohio State University campus will be the locale of the second annual meeting of biological societies under AIBS sponsorship, September 11-13. Invited to the Columbus campus by President H. L. Bevis, the university authorities have ex-

pected every effort to make the meeting of an estimated 2,500 biologists, representing 14 biological societies, a memorable occasion. This meeting includes the *Golden Jubilee Celebration* of the Genetics Society of America, whose program stresses the progress made by scientists who have applied Mendel's theories, as a rebuttal to USSR geneticists. Key-note addresses will be made by Richard Goldschmidt, "The Impact of Genetics upon Science," and by Julian Huxley, "Genetics and Modern Thought."

Some 700 technical papers will be presented at the three-day sessions of the various societies. In addition to these, a number of symposia, as well as individual addresses, will cover broader aspects of the biological sciences and their impact upon society. Among these will be "Vegetation Mapping" and "Application of Ecological Knowledge to Human Affairs" (Ecological Society of America); "Physiological Aspects of Growth Regulators" and "Vegetable Varieties and Breeding" (American Society for Horticultural Science); "Botany in American Education" (Botanical Society of America); "The Role of Introgression in Evolution" (Society for the Study of Evolution); "The Fungi Come into Their Own" (first annual lecture of the Mycological Society of America); "Modern Methods of Monographic Work" (American Society of Plant Taxonomists); "The Water Relations of Plants" (American Society of Plant Physiologists); "Problems of Deterioration" (Society of Industrial Microbiologists); "Old and New Pathways in Genetics" (American Society of Human Genetics); "Plans and Policies for Annual Meetings" (AAAS and AIBS); and a "Forum on Publication Problems" (AIBS).

A varied *Ladies Entertainment*, in charge of a number of wives of local Society members, will include trips to near-by historic areas and museums, as well as teas and luncheons. The *Biologists' Smoker*, in the luxurious lounges of the new wing of the Ohio State Museum, will offer an opportunity for the usual social get-together of the biologists. The *Biological Sciences Exhibit* will pro-

vide an opportunity to see the newest "tools of the biologists' trade" in the form of texts and reference books, instruments, supplies, and equipment. A noteworthy part of the photographic display will be a contribution of unusual electron micrographs by Ralph W. G. Wyckoff, of the Laboratory of Physical Biology, National Institutes of Health.

The General Program of the meeting is being mailed to the AIBS-member societies participating in the meetings; others will receive programs upon registration. Individual copies may be secured (price, \$1.00) upon application to the office of the Executive Secretary, American Institute of Biological Sciences, 2101 Constitution Ave., Washington, D. C.

The National Academy of Sciences will hold its autumn meeting October 9-12 in the auditorium and conference rooms of the General Electric Company's Research Laboratory, The Knolls, Schenectady, N. Y. On Monday afternoon the new building of the Research Laboratory will be dedicated. Scientific sessions will be held on Tuesday, Wednesday, and Thursday. On Tuesday evening a public lecture will be given in Memorial Chapel, Union College, by C. P. Rhoads, director, Sloan-Kettering Institute for Cancer Research. Members of the Academy are requested to register on Monday afternoon in the lobby of the Research Laboratory. Tickets for luncheons and dinners will be available at the registration desk. Requests for the reservation of hotel rooms should be addressed to Dr. W. D. Coolidge, Chairman, Research Laboratory, General Electric Company, Schenectady.

A southwide chemical conference will be held in Atlanta October 16-18. The American Chemical Society and the Southern Association of Science and Industry are acting as joint sponsors of the meeting, which is designed to accelerate Southern progress in all fields of chemistry. Special technical sessions will be devoted to physical, inorganic, organic, and analytical chemistry, biochemistry, chemical education, and industrial chemistry. A chemical industries session will occupy one full day of the program, with comprehensive

reports devoted to such subjects as opportunities for plastics industries, expansion of petroleum industries, quality control in food and drink industries, and development of new chemical products from Southern raw materials. Information on the meeting may be obtained from Southern Association of Science and Industry headquarters, 5009 Peachtree Road, Atlanta, Ga.

An extensive malaria control program in the Shiraz Valley of Iran is being conducted by the Iran Foundation of New York, the Pennsalt International Corporation, Philadelphia, and the Academy of Natural Sciences of Philadelphia. The American scientific team, assisted by Iranians first trained by the team, has completed DDT spraying of some 145 towns and villages, embracing a population of about 220,000 persons, in the heavily malaria-infested district of Shiraz and adjacent areas. At the same time, under the direction of H. Radclyffe Roberts, managing director of the academy, it has completed the first definitive entomological data on malaria vectors of the area, and has trained and equipped enough Iranian teams to continue the program until this region becomes the first malaria district to be cleared of the disease in Iran.

Michael Reese Hospital Postgraduate School is offering a course in **diseases of the endocrine—physiology and diagnostic methods**—to be held September 18-29. The course, under the direction of Rachmiel Levine, director of the Department of Metabolic and Endocrine research, will consist of lectures and case demonstrations. Tuition is \$100. Further information may be obtained from Samuel Soskin, Dean, Michael Reese Hospital Postgraduate School, 29th Street and Ellis Avenue, Chicago 16, Ill.

A registry of leprosy, sponsored by the Leonard Wood Memorial (American Leprosy Foundation), has been established at the American Registry of Pathology, a department of the Armed Forces Institute of Pathology. The purpose of the reg-

istry is to promote the study of the pathology of leprosy, based on materials contributed from all parts of the world. Contributors are asked to forward specimens in slides, blocks, or fixed tissues, and to give complete identification of the patient, to facilitate follow-up studies, as well as to send adequate abstracts of the clinical data, including details of therapy. Clinical photographs, especially of the individual lesion excised for study, are desired for clinicopathologic correlation. Communications should be addressed to the Director, Armed Forces Institute of Pathology (American Registry of Pathology), Washington 25, D. C.

The National Research Council of Canada has installed in its laboratories research equipment for producing temperatures within a few degrees of absolute zero, by the liquefaction of helium. The new equipment provides a readily available source of very low temperatures for the study of chemical and physical reactions.

The new Office of Basic Instrumentation, recently established at the National Bureau of Standards, will coordinate bureau projects in basic instrumentation, maintain liaison with sponsoring agencies, and arrange for cooperative work on special problems. In addition, it will survey all work in progress in NBS laboratories to determine its pertinence to instrumentation projects, arrange for the evaluation of new instrumentation developments, and direct theoretical and experimental studies of original designs for improved means of measurement not specifically covered by other projects at the bureau.

The registry of rare chemicals, 35 West 33rd Street, Chicago, lists the following wanted chemicals: perilla oil; linamarin; myricin; biliverdin; renin; hypertensinogen; angiotonin; pyrimithamine; 2,3-dimethylbutanol-3; *n*-decyl mercaptan; *n*-tetradecyl mercaptan; *n*-dodecylsulfonic acid; ethyl tannate; *N*-nitrosodiethylamine; 2,7-dihydroxyphenanthrene; benzopyrene; bis-(2-hydroxy-5-chlorocyclohexyl); 1-cyanobutene-1; 1-cyanobutene-3; and 5,5'-diethoxythioindigo.

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By DAVID HALLIDAY, University of Pittsburgh. Besides integrating problems and modern facts, this book explains the philosophical aspects of nuclear physics. Both the assumptions upon which theory is based and the results predicted by the theory are examined. Only the material consistent with modern thought on nuclear physics is stressed, with former concepts revised in the light of current thought. The carefully selected problems were taken, whenever possible, from research papers in the literature. Special effort was made to be precise and consistent in terminology and the use of units. *September 1950. Approx. 540 pages. 282 illus. Prob. \$6.00.*

UNIT OPERATIONS

By GEORGE GRANGER BROWN, University of Michigan, and Associates. Presents an integrated treatment of the unit operation emphasizing the principles that are common to different operations. They are logically classified according to these common basic principles into four groups: solids, fluids; separation by ideal or equilibrium stages; and rates of energy and mass transfer. The book presents a "way of thinking"—distinct from mechanical methods for solving problems—that has proved most helpful. *August 1950. 612 double-column pages. 586 illus. \$7.50.*

STATISTICAL DECISION FUNCTIONS

By ABRAHAM WALD, Columbia University. Written under the sponsorship of the Office of Naval Research, this book presents the foundations of statistical decision functions—a comparatively recent development in general theory. Professor Wald's book provides the principles for multi-stage experimentation, and it includes the general multi-decision problem. The latter treats the important question of deciding with minimum risk which of several alternative decisions is best. *One of the Wiley Publications in Statistics, Walter A. Shewhart, Editor. . . . September 1950. 179 pages. \$5.00.*

MATHEMATICS of RELATIVITY

By G. Y. RAINICH, University of Michigan. Presents the theory of relativity in as simple a form as is consistent with the clarity of the fundamental concepts. In order to present the theory of relativity with maximum clarity the mathematical aspect of the subject has been stressed. Professor Rainich shows how both gravitation and electromagnetism fit exactly into the original theory of curved space. *A book in the Applied Mathematics Series, I. S. Sokolnikoff, editor. . . . September 1950. 173 pages. Prob. \$3.75.*

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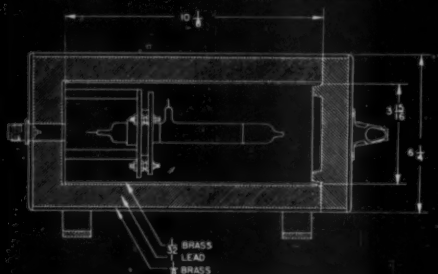
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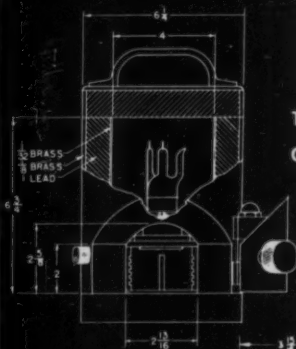
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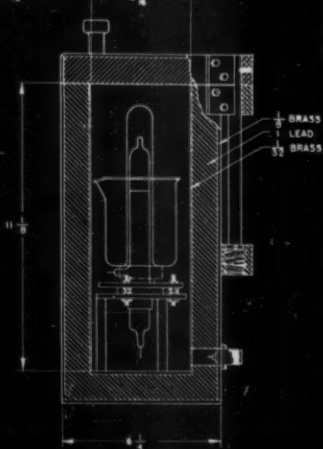


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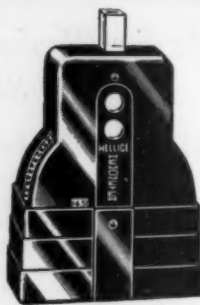
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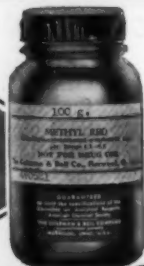
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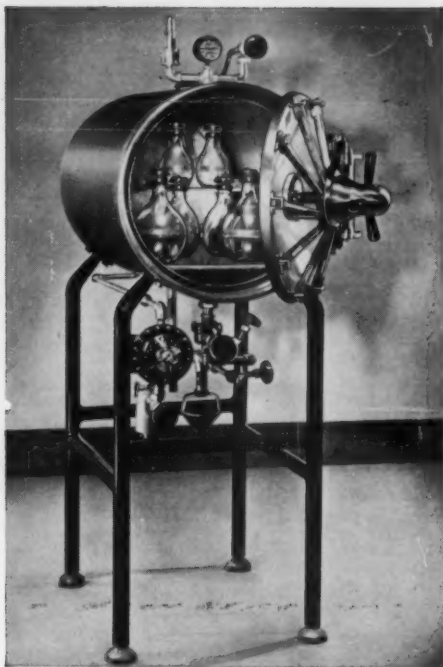
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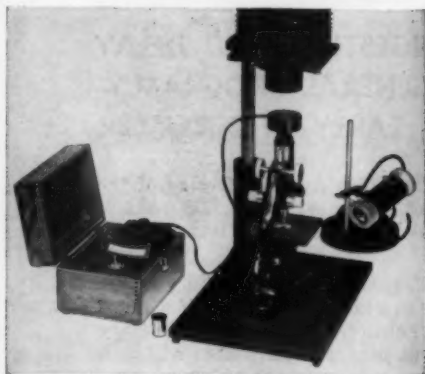
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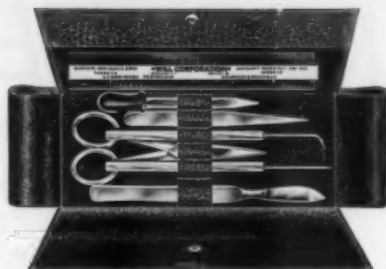
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* A list of the headquarters of each society and section is under **Association Affairs, SCIENCE**, August 25 and in **THE SCIENTIFIC MONTHLY** for September.

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The Market Place

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1. Rate: 20¢ per word for classified ads, minimum charge \$5.00 for each insertion. Such ads are set in uniform style, without display; the first word, only, in bold face type. For display ads, using type larger or of a different style than the uniform classified settings, and entirely enclosed with separate rules, rates are as follows:

Single insertion	\$16.00 per inch
7 times in 1 year	14.50 per inch
13 times in 1 year	13.00 per inch
26 times in 1 year	11.50 per inch
52 times in 1 year	10.00 per inch

2. Payment: For all classified ads, payment in advance is required, before insertion can be made. Such advance remittances should be made payable to SCIENCE, and forwarded with advertising "copy" instructions. For display advertisers, monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

3. Closing Date: Classified advertisements must be received by SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

For proof service on display ads complete "copy" instructions must reach the publication offices of SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., not later than 4 weeks preceding date of publication.

BOOKS

WANTED TO PURCHASE:
SCIENTIFIC PERIODICALS
Sets and runs, foreign and domestic
SCIENTIFIC BOOKS
Entire libraries and smaller collections
WALTER J. JOHNSON
125 East 23rd Street, New York 10, N. Y.

Send us your Lists of
SCIENTIFIC BOOKS and PERIODICALS which you have for sale.
Complete libraries; sets and runs; and single titles are wanted.
Also please send us your want lists.
STECHELT-HAFNER, INC., 31 East 10th Street, New York 3.

Your sets and files of scientific journals
are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. **J. S. CANNER and COMPANY**, 909 Boylston Street, Boston 15, Massachusetts. 9/8

The Market Place

LANGUAGES

LINGUAPHONE MAKES LANGUAGES EASY

At home learn to speak Spanish, Portuguese, Italian, French, German, Russian, by quick easy Linguaphone Conversational Method. Save time, work, money. Send for free book today. LINGUAPHONE INSTITUTE, 84-P Radio City, New York 20.

PROFESSIONAL SERVICES

TRANSLATIONS

... less than 1¢ a word—Write

READERS SERVICE • Box 4523, Washington 17, D. C.

CHEMICAL
CONSULTATION,
RESEARCH,
DEVELOPMENT

THE PANRAY CORP.

Research Division
340 CANAL ST., NEW YORK 13

- Microanalysis (C, H, N, S, Etc.)
- Custom Organic Syntheses
- Chemotherapeutics
- Sponsored Research

• MOTION PICTURE and SLIDE FILM PHOTOGRAPHY

Professional assistance, editing, sound recording, art work, animation, titles, complete productions. Microcinema, Time-lapse studies, photomicrography, optical-electrical engineering. Research and Development. 25 years experience, finest references.

HENRY ROGER, Fellow, A.A.S.; R.M.S.; B.P.A.;
Formerly 11 years with the Rockefeller Institute.
c/o ROLAB Photo-Science Laboratories & Sound Studios,
SANDY HOOK, CONNECTICUT

FOOD RESEARCH LABORATORIES, INC.

Founded 1922

Philip B. Hawk, Ph.D., President

Bernard L. Oser, Ph.D., Director

RESEARCH—ANALYSES—CONSULTATION

Biological, Nutritional, Toxicological Studies
for the Food, Drug and Allied Industries
48-14 33rd Street, Long Island City 1, N. Y.
Write for descriptive brochure

SUPPLIES AND EQUIPMENT

STAINS

STARKMAN Biological Laboratory

• RARE

COMMON

Price list on Request

461 Bloor St., W.
Toronto, Canada

GBI®

For NUTRITIONAL RESEARCH

Write for GBI catalog No. 677 listing products for biochemical, biological, and microbiological procedures.

GENERAL BIOCHEMICALS, INC.

72 LABORATORY PARK CHAGRIN FALLS, OHIO

The Market Place

SUPPLIES AND EQUIPMENT



Cargille MICRO BEAKERS

For direct weighing of small quantities of oils and fats for Iodine Number Determinations (drop the glass beaker and sample into the solution).

For semi-micro procedures.

15 for \$1.00

Gross \$7.50

R. P. CARGILLE (DEPT. 5)

118 Liberty St.

New York 6, N. Y.

ANTHRONE

Newest Reagent for Micro-Colorimetric Determination of Cellulose, Glycogen, Glucose, Galactose, and Carbohydrates.

National Biochemical Co. • 3106 W. Lake St. Chicago 12, Illinois

DON'T MISS

The October 6th EQUIPMENT ISSUE

Both the editorial and advertising pages of this special issue will feature an unusually interesting and comprehensive review of the latest developments in scientific instruments and equipment. It will be of direct interest to the more than 33,000 readers of SCIENCE.

Because of this high reader-interest, this issue will be an all-important medium for Advertisers who wish to reach the persons responsible for purchases for the country's leading educational institutions, industrial laboratories and research foundations.

The effectiveness of this annual issue as an advertising medium is clearly indicated by the fact that the 1949 issue carried more than 40 pages of advertising.

DON'T DELAY—copy must reach us by September 8th if proofs are desired. Regular rates will apply—see CHARGES AND REQUIREMENTS on page 20.

LABORATORY ANIMALS

• Clean healthy well-fed animals

• Guaranteed suitable for your needs.

Reasonably priced—Dependable service

DOGS RATS HARRIS
CATS PIGEONS HAMSTERS
MICE POULTRY GUINEA PIGS

JOHN C. LANDIS • Hagerstown, Md.

GLYCOCYAMINE—Hydroxyproline, L-Methionine

• AMINO ACIDS • BIOCHEMICALS

• PRE-MIXED MICROBIOLOGICAL ASSAY MEDIA

H. M. CHEMICAL COMPANY, LTD.

144 North Hayworth Avenue

Los Angeles 36, California

98% Pure . . .

1 (+) GLUTAMINE

G & W Laboratories, Inc.

370 Ocean Ave., Jersey City, N. J.

White SWISS Mice 20c

Rabbits, Cavies, White Rats, Ducks, Pigeons, Hamsters

Write • J. E. STOCKER • Ramsey, N. J.

All Amino Acids (natural, synthetic, unnatural),

Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.

BIOS LABORATORIES, INC. 17 West 60th Street. New York 23, N. Y.

Available Now . . .

L-Threonine

DI-Allothreonine

**In addition to DI-Threonine
and other amino acids**



SPECIAL CHEMICALS DIVISION

Winthrop-Stearns INC.

1450 BROADWAY, NEW YORK 18, N. Y.

GLASS ABSORPTION CELLS made by **KLETT**



Makers of Complete Electrophoresis Apparatus

—SCIENTIFIC APPARATUS—

Klett-Summerson Photoelectric Colorimeters—
Colorimeters—Nephelometers—Fluorimeters—
Bio-Colorimeters—Comparators—Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York

THE RICKETTSIAL DISEASES OF MAN

This symposium volume is a comprehensive survey of the general field of Rickettsial diseases in man. Among the contributors appear the names of many of the foremost American authorities on this important and relatively new field of medicine.

The first group of papers includes discussions of the taxonomy, biology, isolation, and identification of vectors, and reservoirs of infection of the Rickettsial diseases of man. The second group of papers is devoted to discussions of serological reactions, the Weil-Felix reaction, the complement-fixation and agglutination reactions, and the preparation and standardization of Rickettsial vaccines. The final group of papers treats of insecticides, methods of their application, and mite controls.

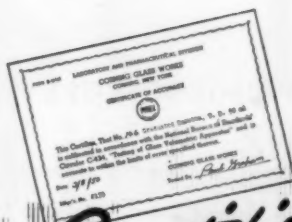
Many of the 27 contributors to this volume during World War II were on the battle fronts in Africa, Italy, France and Germany, protecting our troops and the local populations wherever Rickettsial diseases prevailed. Rarely, if ever, have the authors of a medical book had so wide and so successful practical experience in the very subjects on which they have written.

**ORDER
YOUR
COPY
NOW**

To: A.A.A.S. Publications
1515 Massachusetts Avenue, N.W., Washington 5, D. C.

Please accept my order for one copy of *The Rickettsial Diseases of Man* (7½ x 10½, cloth bound). My check in correct payment is enclosed (\$5.25 to A.A.A.S. members, \$6.25 to those who are not members; including postage.)

Name
Address
City Zone State

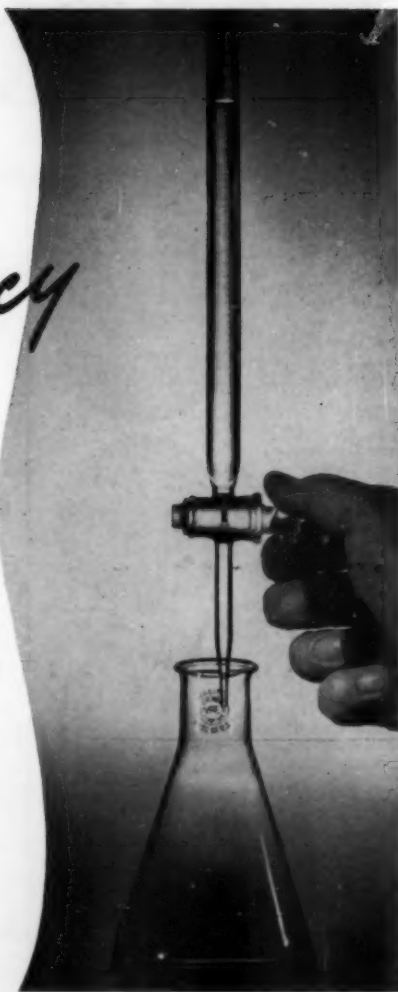



Certified Accuracy

With New PYREX brand PRECISION BORE Burettes

PYREX brand Burettes are now available, manufactured from *precision bore* tubing. Naturally this insures overall accuracy but it also means *greater* accuracy between each individual graduation. Each Burette is individually calibrated and tested and a Corning certificate guarantees it to be within Class A tolerances as established by Bureau of Standards Circular C-434.

Corning does many things to give you outstanding Burette value. The tips are gauged for uniform measured flow. The use of PYREX brand glass No. 7740 provides high resistance to thermal and physical shock, and protection against pH change in standard solutions. A beaded rim further increases strength. The stop cock, sealed solidly to the body, is precision-ground for ease of turning and leak-proof shut-off. This all adds up to better value through greater accuracy and longer service life. PYREX brand Burettes (50 ml only) are available from your laboratory supply dealer. Call him today.



This mark  identifies manufacture by Corning

CORNING GLASS WORKS



CORNING, N. Y.

Corning means research in Glass

Technical Products Division: { Laboratory Glassware, Glass Pipe, Plant Equipment, Lightingware, Signalware, Gauge Glasses, Optical Glass, Glass Components

New Improved

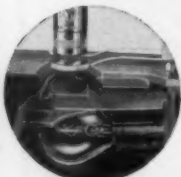


SPENCER SCHOLAR'S MICROSCOPE

BETTER 4 WAYS FOR TEACHING

Stage Temperature Favors Most Living Material

New heat-absorbing glass and baffle plate prevent overheating.



Saves Time Teaching Science

So easy to learn and to use...more time is free for teaching *Science*. Simple controls permit more rapid operation.



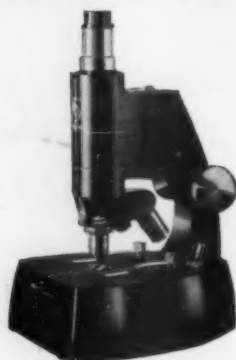
A Precision Scientific Instrument

Standard quality Spencer trademarked optics. Precise all-metal bearing surfaces.



Low Cost to Buy and Maintain

Locked-in parts reduce maintenance costs. 'Spring loaded' focusing mechanism protects slides.



● Spencer No. 78 Scholar's Microscope, with built-in factory-focused light source furnishes constant, uniform illumination and consequently better optical performance. Time-consuming and frequently faulty sub-stage adjustments are eliminated. Reversed position of microscope arm offers clear view of stage, objectives, and diaphragm openings. Low over-all height increases comfort. Time-saving single control provides rapid yet critical focusing. Ask your AO Distributor to show you the No. 78 Microscope... or write for catalog M153 to Dept. J1.

American Optical

COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK

Makers of Precision Optical Instruments for over 100 Years

